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EVALUATION OF EARLY VS INTERVAL LAPAROSCOPIC CHOLECYSTECTOMY FOR ACUTE CHOLECYSTITIS; AN OBSERVATIONAL STUDY

DR. SHALU YADAV

UNDER SUPERVISION OF

DR. SAMEER H. NAQASH

DEPARTMENT OF GENERAL SURGERY

SANTOSH MEDICAL COLLEGE & HOSPITAL

GHAZIABAD, NCR DELHI

SANTOSH DEEMED TO BE UNIVERSITY

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Prof. (Dr.) Sameer H. Naqash
Professor & Consultant
Department of General Surgery
Santosh Medical College & Hospital
Ghaziabad, NCR, India

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Co-Guide

Dr. Jai Prakash
Consultant
Department of General Surgery
Santosh Medical College & Hospital
Ghaziabad, NCR, India

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Prof. (Dr.) Yogendra Kumar

Professor & Head
Department of General Surgery
Santosh Medical College & Hospital
Ghaziabad ,NCR, India

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Prof. (Dr.) Alka Agrawal

Dean
Faculty of Medical Sciences
Santosh Medical College & Hospital
Santosh Deemed to be University
Ghaziabad, NCR, India

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Dr. SHALU YADAV
MD/MS student of batch 2022-2023
Department of GENERAL SURGERY
Email: shaluss2601@gmail.com

Copy to:

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ABBREVIATION

LC	**:**	LAPAROSCOPIC CHOLECYSTECTOMY
EC	**:**	EARLY CHOLECYSTECTOMY
DC	**:**	DELAYED CHOLECYSTECTOMY
CBD	**:**	COMMON BILE DUCT
SGOT	**:**	SERUM GLUTAMIC OXALOACETIC TRANSAMINASE
SGPT	**:**	SERUM GLUTAMIC PYRUVIC TRANSAMINASE
ALP	**:**	ALKALINE PHOSPHATASE
USG	**:**	ULTRASONOGRAPHY
CT	**:**	COMPUTED TOMOGRAPHY
MRCP	**:**	MAGNETIC RESONANCE CHOLANGIOPANCREATICOGRAPHY

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“EVALUATION OF EARLY VS INTERVAL LAPAROSCOPIC CHOLECYSTECTOMY FOR ACUTE CHOLECYSTITIS; AN OBSERVATIONALSTUDY”

ABSTRACT

Introduction

Acute cholecystitis, often associated with gallstones, presents a clinical dilemma regarding the timing of laparoscopic cholecystectomy (LC). The choice between early laparoscopic cholecystectomy within 7 days of symptom onset and delayed laparoscopic cholecystectomy after initial conservative management of about 6 weeks hinges on various factors such as patient health, surgical expertise, and hospital resources. Early intervention, while reducing hospital stay and preventing complications, poses risks due to inflamed tissues complicating surgery, potentially leading to increased operation times and conversion to open surgery. Conversely, delayed surgery allows inflammation to subside, reducing surgical difficulty but increasing the risk of interim complications and repeated hospital visits.

Aims and Objectives

This study aims to compare the outcomes of early versus interval laparoscopic cholecystectomy in patients with acute cholecystitis, focusing on:

- Operating time
- Post-operative complications
- Operative complications
- Total hospital stays
- Financial implications

Methodology

This hospital-based observational study was conducted at Santosh Medical College and Hospital, Ghaziabad, involving 72 patients divided into two groups (36 each for early and interval laparoscopic cholecystectomy). Data on demographics, clinical

presentations, and outcomes were collected and analysed using descriptive statistics and inferential tests, with significance set at p-value < 0.05

Results

The two groups showed no significant differences in baseline characteristics, including age ($p = 0.59$), gender distribution ($p = 0.795$), site of pain ($p = 0.56$), or duration of symptoms ($p = 0.4$). While nausea and vomiting were significantly more common in one group, other clinical features such as fever were similarly distributed. A significant difference was noted in the presence of pericholecystic oedema, predominantly in Group 1 ($p < 0.001$), and gallbladder status also varied significantly in terms of distension and oedema ($p < 0.05$). Laboratory values revealed significant differences only in SGOT and ALP levels. Intraoperative findings indicated more complex pathology in Group 1, including frozen Calot's triangle and empyema, which corresponded with a slightly longer mean operative time (80.6 vs. 79.7 minutes) but with no statical significance. Despite these differences, postoperative complications were comparable between groups ($p = 0.5$). The length of hospital stay was also not significantly different ($p = 0.49$), suggesting that the intraoperative challenges did not substantially prolong recovery time.

Conclusion

Early laparoscopic cholecystectomy for acute cholecystitis, despite more challenging surgical conditions and slightly longer operative time, does not increase the incidence of post-operative complications compared to interval surgery. The decision on the timing of laparoscopic cholecystectomy should consider individual patient conditions, hospital capabilities, and potential risks associated with delayed treatment. Further studies with larger sample sizes are recommended to validate these findings and refine guidelines for the management of acute cholecystitis.

INTRODUCTION

INTRODUCTION

Acute cholecystitis accompanied by gallstones, medical professionals face a strategic choice between two primary surgical approaches regarding the timing of laparoscopic cholecystectomy (LC), a minimally invasive procedure to remove the gallbladder. The decision is influenced by various factors including the patient's health condition, the available surgical expertise, and the hospital's resources. The first option, Early Laparoscopic Cholecystectomy, involves performing the surgery within the first 7 days after symptoms appear. This approach is favoured for its potential to decrease the overall length of hospital stay and to prevent further complications associated with gallstones, such as pancreatitis or repeated episodes of cholecystitis. [1] conducting surgery during the acute phase of inflammation presents significant challenges. The swollen and tender tissues can complicate the surgical procedure, obscuring critical anatomical landmarks and increasing the risk of accidental damage to surrounding structures like the bile duct. These difficulties can extend the duration of the surgery and heighten the probability of needing to switch to an open surgical method, which is more invasive and requires a longer recovery period. On the other hand, the second approach involves Conservative Treatment followed by Interval Cholecystectomy after a waiting period of about 6 weeks. During this interval, medications and supportive care are used to manage symptoms and reduce inflammation. Delaying surgery allows the acute inflammation to subside, which can simplify the surgical procedure by providing clearer visibility and more stable tissues, thus reducing the likelihood of surgical complications and the need for conversion to open surgery. However, this approach carries the risk of interim complications from the gallstones, such as the potential for further gallstone attacks or other biliary issues, which could necessitate urgent medical attention. [2] This strategy involves multiple hospital admissions, which can increase the financial burden and logistical inconvenience for the patient. With advancements in surgical techniques and perioperative care, there has been an increasing trend towards favouring early laparoscopic cholecystectomy, even in challenging cases of acute inflammation. Studies have shown that with experienced surgeons and adequate preparation, early laparoscopic cholecystectomy can be performed safely and effectively, minimizing the need for conversion to open surgery and providing faster recovery for patients. The ultimate decision on the timing of surgery must be carefully tailored to each individual's specific health circumstances,

taking into account their overall fitness for surgery, the severity of their symptoms, and the specific capabilities of the treating hospital. Biliary tract diseases rank among the most common abdominal disorders encountered by surgeons, gastroenterologists, [3] and radiologists, second only to appendicitis. Within this category, diseases of the gallbladder are most frequently seen in clinical practice. Acute cholecystitis, characterized by inflammation of the gallbladder, typically arises in conjunction with cholelithiasis (gallstones) and is notably prevalent in certain environments. Several factors elevate the risk of developing acute cholecystitis, including compromised immune systems, sepsis, diabetes, and prolonged reliance on total parenteral nutrition, which bypasses the gastrointestinal tract. The inflammation associated with acute cholecystitis can lead to a range of complications, including chronic inflammation, empyema (accumulation of pus within the gallbladder), mucocele (distension of the gallbladder due to mucus accumulation), and even perforation of the gallbladder, which can lead to severe, life-threatening infections within the abdominal cavity. One of the challenges in treating acute cholecystitis is the anatomical distortion caused by inflammation and adhesions in Calot's triangle—a key area surgeons focus on during cholecystectomy to safely identify and manage the cystic artery and cystic duct. This distortion can make delayed cholecystectomy more challenging and hazardous. The management of cholecystitis also carries significant socioeconomic implications. The decision between immediate and delayed surgical intervention not only affects clinical outcomes but also has considerable impacts on healthcare costs and resources, emphasizing the need for careful consideration of treatment strategies. The management of acute cholecystitis, now universally recognized to require surgical intervention, still invites debate over the optimal timing of cholecystectomy. Presently, three distinct approaches to the timing of surgery are practiced, each reflecting different clinical judgments about how to balance the risks of surgery with the benefits of early gallbladder removal. [4] The first approach, which is traditional, involves elective surgery. This method waits for an initial round of medical treatment to mitigate the inflammation, followed by surgery during a subsequent hospitalization. This delay allows the acute inflammation to subside, which can make the surgical procedure technically simpler and safer. The second approach is delayed cholecystectomy but still within the same hospital stay. This strategy involves a short period of medical management to control the inflammation, with surgery scheduled later in the course of the same hospitalization. This method aims to reduce the inflammation slightly while

still addressing the problem in a timely manner to prevent further complications. The third approach advocates for an early cholecystectomy, performed as soon as possible after admission. This immediate action is favoured to quickly resolve the condition and potentially shorten the total hospital stay, but it does carry a higher risk of surgical difficulties due to ongoing inflammation. Recent studies have largely concentrated on determining the most advantageous timing for cholecystectomy within the same hospital stay. These studies debate whether it is better to operate in the acute phase of the disease or to allow some time for medical treatments to reduce inflammation. The ongoing research reflects a continuous effort to refine surgical timing to optimize patient outcomes, balancing immediate intervention against the risk of complications from operating on an inflamed gallbladder. Laparoscopic cholecystectomy (LC) is the established standard operation for acute cholecystitis, widely recognized for its minimally invasive nature. Traditionally, the treatment for acute cholecystitis involved a two-stage approach: initially managing the patient conservatively to allow the inflammation to subside, followed by an interval laparoscopic cholecystectomy during a later admission. Laparoscopic cholecystectomy was cautiously used in the setting of acute cholecystitis due to concerns about higher complication rates, particularly the risk of injuring the common bile duct and a notable increase in the need to convert to open cholecystectomy. While elective laparoscopic cholecystectomy typically sees conversion rates ranging from 3% to 7%, these rates can soar up to 30% in the presence of acute inflammation recent studies have challenged this cautious approach by demonstrating favorable outcomes when LC is performed early—specifically within 96 hours of admission. These findings suggest that early cholecystectomy (EC) might be more beneficial compared to the traditional delayed cholecystectomy (DC). EC, typically performed within 2 to 3 days of patient presentation, aims to resolve the condition swiftly before the inflammation worsens, potentially reducing the risk of complications and shortening the hospital stay. On the other hand, DC, planned for 6 to 10 weeks after the initial conservative management period, remains a viable option, particularly when early surgery is deemed too risky due to severe inflammation or when the surgical setting is not ideal for emergency procedures. Large surgical centres have reported [5] successful outcomes with urgent laparoscopic cholecystectomy, indicating that with adequate surgical expertise and proper patient selection, early laparoscopic cholecystectomy can be safely performed even in the acute phase of cholecystitis. This shift towards early intervention reflects an evolving understanding of the disease

management and growing confidence in surgical capabilities, especially in well-equipped, high-volume centres. The debate over the optimal timing for laparoscopic cholecystectomy (LC) in the treatment of acute cholecystitis has been ongoing, with significant developments over the decades. Early studies on early cholecystectomy (EC) as a treatment approach date back to the 1950s, and the first controlled study in 1970 by Vander Linden and Sunzel highlighted the benefits of EC, such as lower morbidity rates and shorter hospital stays. These early findings set the stage for further investigation into the advantages of performing cholecystectomy soon after diagnosis. The 1990s marked a pivotal era with the exponential growth of laparoscopic techniques, enhancing the feasibility of early surgical intervention. Throughout the early 1980s, several randomized studies reinforced the superiority of Early cholecystectomy over delayed cholecystectomy, showing better operative feasibility, fewer postoperative complications, and reduced length of hospital stays. Despite the accumulating evidence supporting Early cholecystectomy, controversies persist. Initially, laparoscopic cholecystectomy was deemed risky during acute episodes due to high conversion rates to open surgery—estimated at 60% in early practices—and concerns about bile duct injuries. These risks contributed to the hesitancy in adopting Early cholecystectomy universally. The present study in our hospital aims to provide updated insights by comparing intraoperative and postoperative morbidity between early and interval cholecystectomy.

The rationale for conducting an observational study to evaluate early versus interval laparoscopic cholecystectomy for acute cholecystitis stems from the ongoing debate and lack of consensus on the optimal timing for surgical intervention in this common and impactful health issue. Despite the well-established role of laparoscopic cholecystectomy as the preferred treatment for gallbladder removal, the decision on whether to perform this surgery early (within a few days of symptom onset) or after a delay (post-initial conservative management) remains contentious. This study aims to provide empirical evidence by comparing the outcomes of early cholecystectomy (EC) and delayed or interval cholecystectomy (DC) within the same hospital setting. By observing and analysing variables such as intraoperative difficulties, postoperative complications, total hospital stay, cost-effectiveness, and overall patient quality of life, the study seeks to delineate which surgical timing offers the most benefits or poses fewer risks. This could significantly impact clinical practices and guidelines, potentially

leading to improved patient outcomes in managing acute cholecystitis. The findings may help clarify surgical planning and resource allocation in healthcare settings, aligning treatment approaches more closely with patient needs and healthcare capabilities.

AIM AND OBJECTIVES

AIMS AND OBJECTIVE

The aims and objectives of this study are as follows:

1) to evaluate the results of early laparoscopic cholecystectomy in patients with acute cholecystitis with cholelithiasis in our setup with attention to clinical outcome,
2) to compare the results of early with the interval laparoscopic cholecystectomy for the treatment of acute cholecystitis with cholelithiasis in relation to
    - operating time
    - post operative complications
    - operative complication
    - length of total hospital stays
    - financial burden

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The timing of surgical intervention for acute cholecystitis has been a subject of considerable debate among medical professionals. Early pioneers in this debate include Walton, who in 1923 was among the first to advocate for early operations as a strategy to mitigate the risks associated with acute cholecystitis. Following Walton, Charles S. Jones in 1960 proposed [7] that early surgery could potentially reduce mortality rates for these patients, suggesting a shift towards more proactive surgical management. The view on optimal timing for surgery was further examined in the 1950s. Roggs and Dunphy, after surveying 150 surgeons in 1950, reported a consensus that the period from the fourth to the twelfth day following an acute attack posed significant risks, thereby supporting immediate surgery regardless of the duration of the condition. Similarly, Pines and Robinowoth in 1954 observed that morbidity and mortality rates increased sharply after the fourth day post-attack. In more recent decades, Rise et al. in 1979 clearly defined early surgery as operations performed within seven days of hospital admission, contrasting with delayed surgery which followed a period of conservative management and a substantial delay, typically of six months, before operating. Contemporary research continues to evaluate these approaches. For instance, Abdullah M. Taha et al. have found that early cholecystectomy is not only feasible but also safe, effectively providing definitive treatment during the initial hospital admission and preventing the complications associated with failed conservative management and the necessity for emergency surgeries later. Additionally, a meta-analysis by X. Dwu, M-Liu et al. compared early laparoscopic cholecystectomy (ELC) with delayed laparoscopic cholecystectomy (DLC). Their findings suggest that early laparoscopic cholecystectomy is superior in terms of cost-effectiveness, safety, and patient satisfaction, also highlighting reduced hospital costs and fewer days lost from work. These historical and modern perspectives collectively underscore the evolving understanding and approach to managing acute cholecystitis, with a growing body of evidence supporting early intervention. [8]

ANATOMY OF GALLBLADDER:

The gallbladder is a small, pear-shaped organ located within the abdominal cavity, specifically in the right hypochondriac region. It serves as a temporary reservoir for bile, a digestive fluid produced by the liver. Bile is concentrated in the gallbladder and is released into the small intestine in response to food intake, particularly fats, to aid in digestion. Anatomically, the gallbladder sits in a fossa on the inferior aspect of the liver, nestled between the right lobe and the quadrate lobe. As a peritoneal structure, it is lined by a serous membrane that forms part of the peritoneum, which also covers most of the abdominal organs. The positioning and structure of the gallbladder make it integral to the digestive system, helping to efficiently process and absorb dietary fats. [9]

ANATOMICAL RELATIONS OF GALLBLADDER:

Anteriorly and superiorly: Inferior border of the liver and the anterior abdominal wall

Posteriorly: Transverse colon and proximal duodenum

Inferiorly: Biliary tree and duodenum

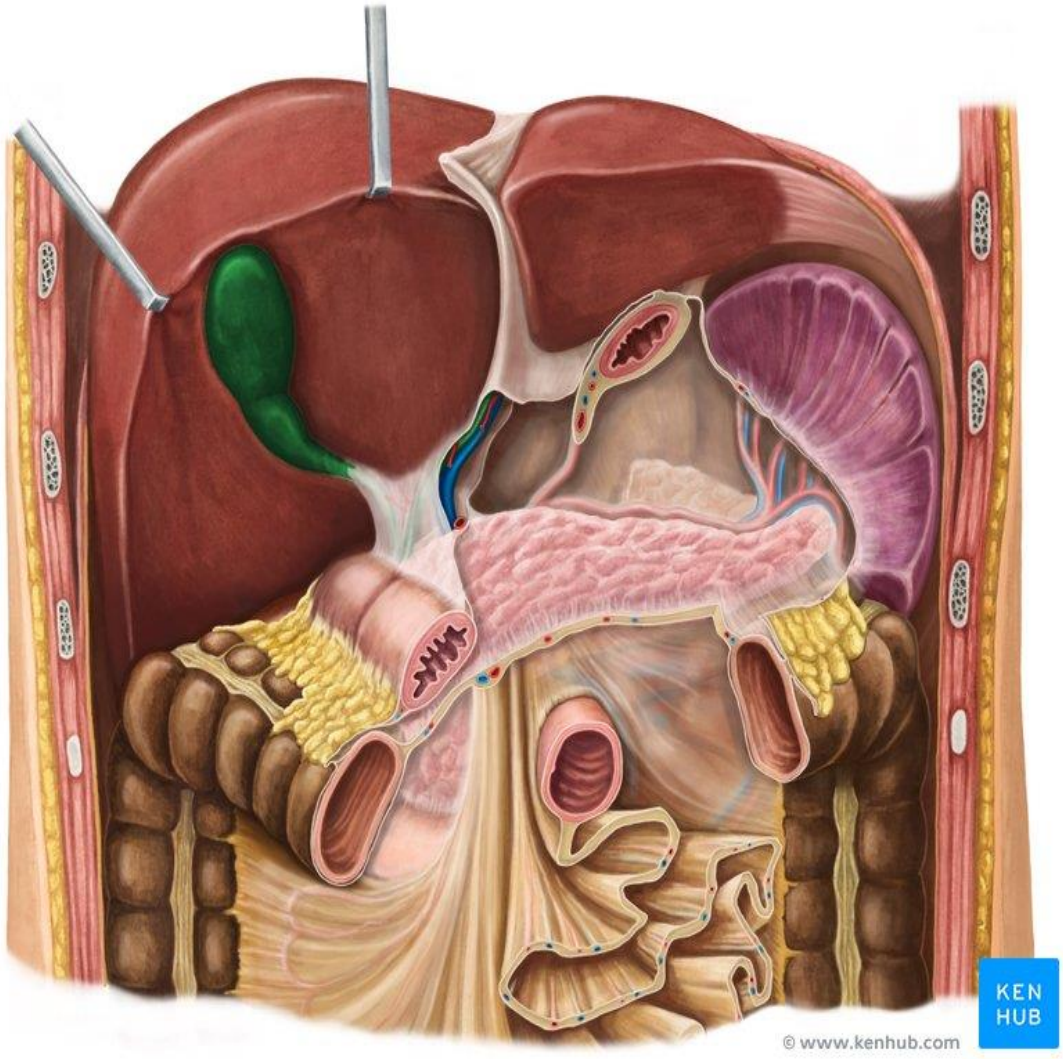


Figure 1: Anatomic Relations of Gallbladder

ANATOMICAL STRUCTURE OF GALL BLADDER:

The gall bladder is a diverticulum of the extrahepatic biliary system and is distributed irregularly in the animal kingdom. Gall bladder is only found in the vertebrates and appears first in the cyclostoma. All the carnivores except the whales have gallbladder as have all reptiles and amphibians. Herbivores and birds vary: Giraffes seem to be losing theirs, while seals, otters, walruses, rats, horses and elephants have no gallbladders. The extrahepatic biliary system[10], otherwise the extrahepatic biliary apparatus consists of

- Common hepatic duct
- Gall bladder
- Cystic duct
- Common bile duct

GALLBLADDER:

The human gallbladder is a small, slate-blue, pear-shaped sac that plays a crucial role in the digestive system. It is partially embedded in a fossa on the inferior surface of the liver, extending forward from near the right end of the porta hepatis to the inferior border of the liver. Its upper surface is secured to the liver by connective tissue, which helps anchor it in place, while the rest of the gallbladder is enveloped in peritoneum, a continuous membrane that extends from the liver's surface. In some instances, the gallbladder may even be connected to the liver via a short mesentery, although this is less common. In adults, the gallbladder measures approximately 7.5 to 12.5 cm in length and 3 cm across at its widest point. It has a capacity of 30 to 50 ml but can expand significantly under certain pathological conditions. The gallbladder is anatomically divided into several parts: the fundus, which is the rounded end farthest from the liver; the body, which is the main and central part; the infundibulum, which is a funnel-like extension; and the neck, which tapers down and connects to the cystic duct. Through these structures, bile produced in the liver is stored and concentrated, ready to be released into the small intestine to aid in the digestion of fats. [11]

FUNDUS:

The expanded end of the gall bladder is known as fundus. It usually projects downwards ,forwards and to the right ,extending beyond the inferior border of the liver to contact the anterior abdominal wall behind the ninth right costal cartilage ,where the lateral edge of the right rectus abdominis muscle crosses the costal margin .Posteriorly it is related to the transverse colon , near its commencement .These relations change when the gallbladder is lower , it is in slender females. [12]

BODY:

The largest part of the gall bladder, it is occasionally in contact with the transverse colon and proximal duodenum. The body is directed up, back and to the left, near the right end of the porta it is continuous with the infundibulum of the gall bladder. It is related above to the liver, below to the transverse colon and further back to the first and upper end of the second segments of the duodenum. [13]

INFUNDIBULUM:

The infundibulum is the part between the body and neck of the gallbladder. Hartmann's pouch is a bulging of the inferior surface of the infundibulum, which is the first part usually to form adhesions to this part of the gut. Broca first described Hartmann's pouch, and it was regarded as a constant feature of gallbladder. But Davies and Harding [1942] have shown its association with pathological conditions, especially dilatations. [14]

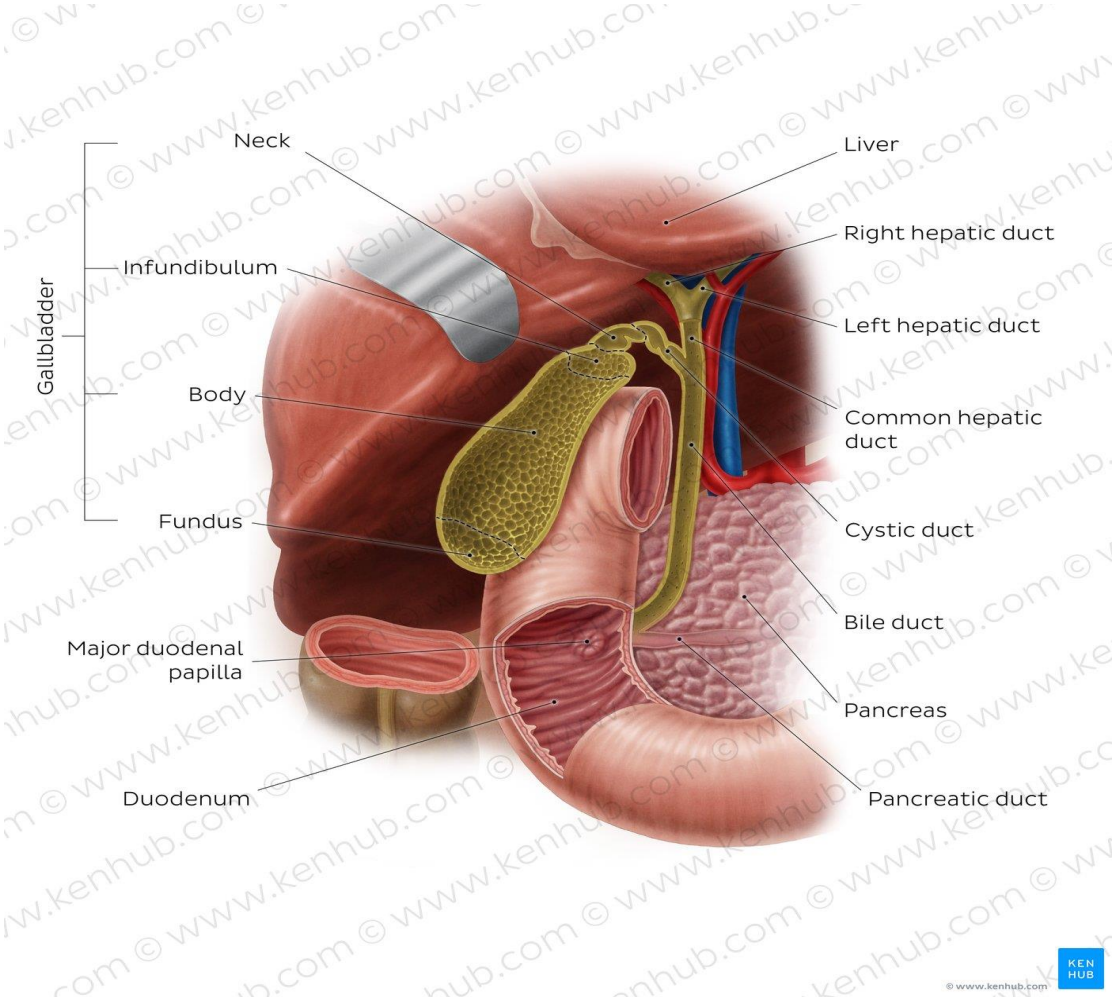


Figure 2: Parts of Gallbladder

NECK:

Here, the gall bladder tapers to become continuous with the cystic duct leading to the biliary tree. The neck contains a mucosal fold, known as Hartmann's pouch. This is a common location for gallstones to become lodged causing cholelithiasis.

The neck is narrow, curving up and forwards and then abruptly back and downwards, to become the cystic duct, at which transition there is a constriction. The neck is attached to the liver by loose connective tissue containing the cystic artery. The mucosa of the neck is obliquely, forming a spiral valve; when the neck is distended, this gives its surface a spiral groove. [15]

ANATOMY RELEVANT TO CHOLECYSTECTOMY:

Knowledge of relevant anatomy is important for safe execution of any operative procedure. Specifically in the context of a cholecystectomy. It has been recognized since long that misinterpretation of normal anatomy as well as the presence anatomical variations contribute to the occurrence of major postoperative complications especially biliary injuries. [16]

CYSTIC DUCT:

The cystic duct is a crucial anatomical structure that connects the gallbladder to the common bile duct. Its proper identification and careful handling during cholecystectomy (the surgical removal of the gallbladder) are essential to avoid surgical complications. The cystic duct typically varies in length, usually measuring between 2 to 4 cm, though about 20% of cystic ducts are less than 2 cm long. This variability can pose challenges during surgery, as shorter ducts provide limited space for placing surgical clips or ligatures, which are used to seal the duct to prevent bile leaks. The cystic duct's diameter is generally 2 to 3 mm but can dilate if there is an underlying pathology. This dilation is significant because the normal bile duct is approximately 5 mm in diameter. Therefore, a dilated cystic duct can sometimes be mistaken for a bile duct, which can lead to surgical errors if not identified correctly. [17] A cystic duct that appears larger than 5 mm should raise concerns about potential misidentification with the bile duct, prompting careful reassessment before it is clipped or ligated during surgery. Anatomically, the cystic duct joins the gallbladder at the neck, where the angle

of junction can be quite sharp. The junction may appear as a smooth tapering or an abrupt connection. Although rare, anomalies such as double cystic ducts do occur and can complicate the surgical landscape significantly. The presence of two duct-like structures entering the gallbladder should always be approached with caution and thoroughly investigated to avoid misidentification and ensure surgical safety.

CALOT 'S TRIANGLE: [18] Currently, laparoscopic cholecystectomy is widely accepted as the gold standard in the treatment of cholelithiasis. This new technique was initially associated with a significant increase in morbidity, and in iatrogenic biliary injury and arterial hemorrhage, perhaps due to a lack of knowledge of the laparoscopic anatomy of the gallbladder pedicle. Therefore, the laparoscopic surgeon has to deal with the new anatomical views and must be aware of the possible arterial and biliary variants.

A good knowledge of Calot's triangle is important for conventional and laparoscopic cholecystectomy. Calot's triangle is an important imaginary referent area for biliary surgery. In 1981, Rocko drew attention to possible variations in the region of Calot's triangle bordered by the cystic duct, common hepatic duct, and lower edge of the liver. In 1992, Hugh suggested Calot's triangle should be renamed the hepatobiliary triangle, with the small cystic artery branches supplying the cystic duct being called Calot's. The contents of Calot's triangle typically include the right hepatic artery, the cystic artery, the lymph node of Lund, as well as connective tissue and lymphatics. During a cholecystectomy, the dissection of Calot's triangle is crucial for the identification and safe management of the cystic artery and cystic duct, which must be ligated and divided to remove the gallbladder. Due to the variable anatomy and the often-compact nature of the space, dissecting within Calot's triangle can be particularly challenging. Surgeons must navigate this small potential space carefully to avoid damaging any surrounding structures, especially the bile duct on the left boundary of the triangle. The bile duct is perhaps the most critical structure within this triangle due to its size and the severe complications that can arise from its injury. Protecting the bile duct during surgery is paramount to prevent bile leaks and other significant postoperative issues. Therefore, clear visualization and meticulous dissection within Calot's triangle are essential steps in performing a safe and effective cholecystectomy. [19]

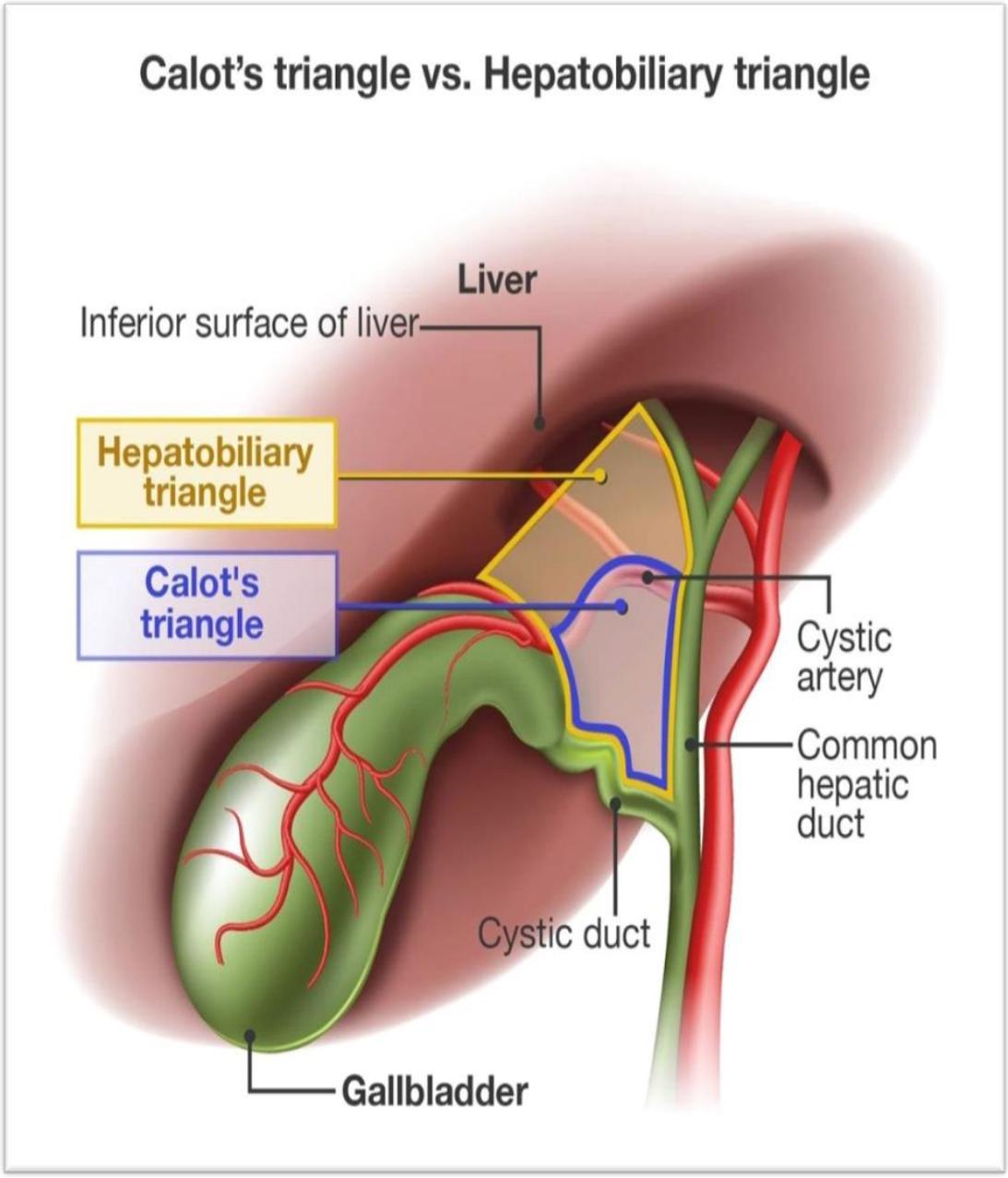


Figure 3: Calot's and Hepatocystic Triangle

ANOMALIES OF THE CYSTIC AND HEPATIC ARTERY:

There are a fair number of other arterial variations of the cystic artery. There is a 2 to 15% incidence of double cystic artery. Therefore, it may be occasionally necessary to ligate two arteries to the gallbladder. When the cystic artery is given off not from the RHA but from common hepatic artery or left hepatic artery it crosses the bile duct anteriorly and may be prone to injury. An accessory or replaced RHA from superior mesenteric artery which is a variation seen in almost 15% of the individuals the RHA courses through the calot's triangle and in turn has a shorter cystic artery. [20]

ANOMALIES OF GALL BLADDER:

Anomalies in number:

- Agenesis of the gall bladder.
- Duplication of the gall bladder.
- Triple gall bladder.

Anomalies in shape:

- Bilobed gall bladder.
- Rudimentary gall bladder.
- Diverticulum of the gall bladder.
- Hourglass stricture or dumb bell gall bladder.
- Phrygian cap gall bladder.
- Multiseptated gall bladder.
- Kinking of the gall bladder.

Anomalies in position.

- Left sided gall bladder.
- Floating gall bladder.
- Intra hepatic gall bladder.
- Retro displaced gall bladder.
- Supra hepatic gall bladder.

Anomalies in Cystic Duct: [21]

- Very short or long cystic duct.
- Absence of cystic duct.
- Cystic duct opening into the right or left hepatic duct.
- Cystic duct opening directly into the duodenum.
- Accessory cystic duct passes from gallbladder to the liver.

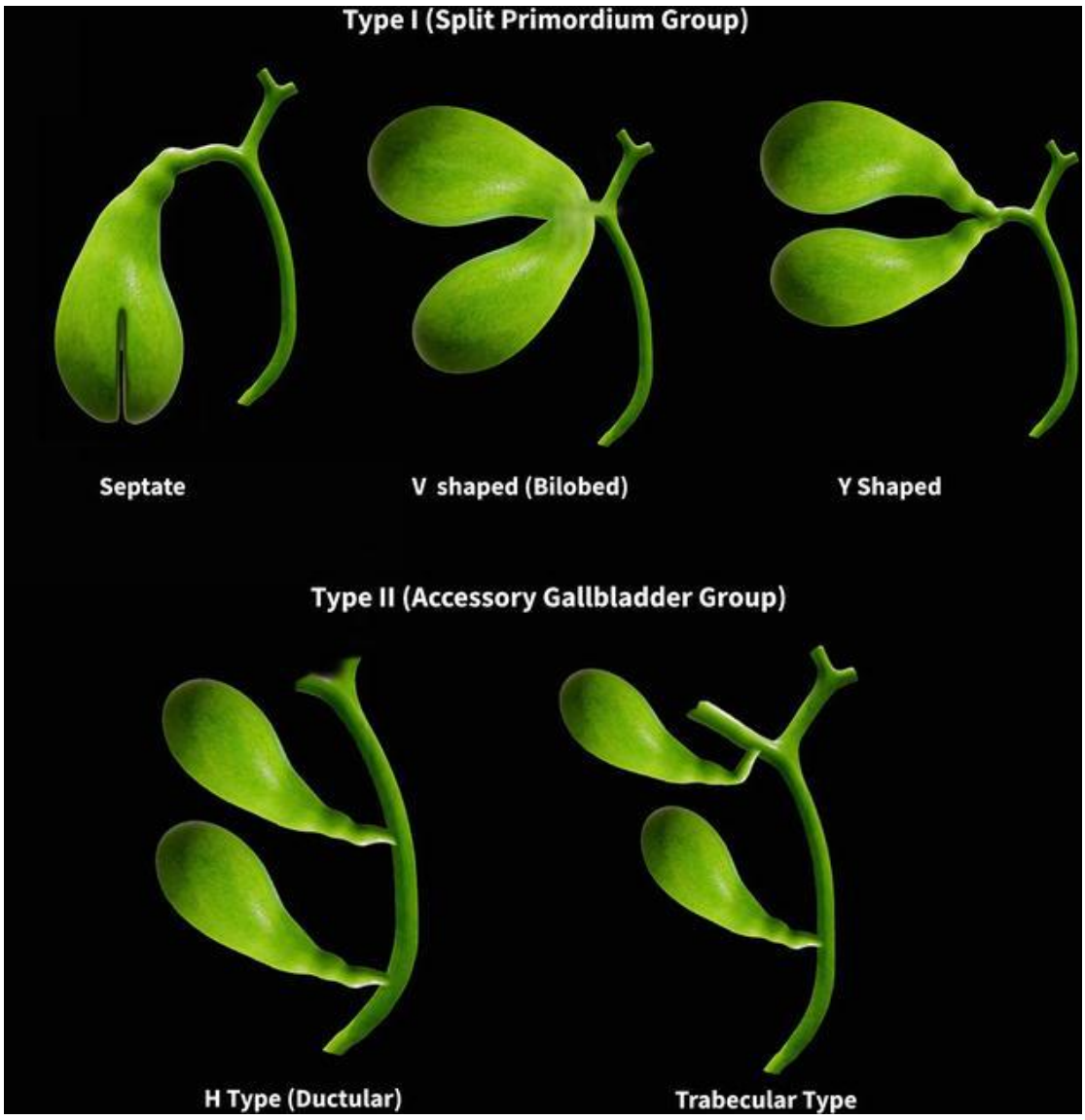


Figure 4: Anomalies of Gallbladder

ACTION OF GALLBLADDER:

The gallbladder plays a supportive role in digestion by storing and concentrating bile, a digestive fluid produced by the liver, and releasing it into the small intestine in response to food intake, particularly fats. However, the removal of the gallbladder, a procedure known as cholecystectomy, demonstrates that this organ is not essential for digestion. Patients who have undergone a cholecystectomy generally maintain good health and proper nutrition. After the gallbladder is removed, bile no longer has a storage area and instead flows directly from the liver into the duodenum via the bile ducts at a slower and more constant rate. Over time, the bile ducts may become slightly dilated to accommodate the continuous flow of bile. Interestingly, the release of bile tends to increase after meals due to the liver producing more bile in response to eating, especially foods that contain fats. Most individuals who have had their gallbladder removed can still enjoy a relatively normal diet, including fried foods. However, because there is no longer a reservoir to regulate the release of bile into the intestines, patients might experience difficulty digesting very high-fat meals. Thus, they are generally advised to moderate their intake of such foods to avoid digestive discomfort. This adaptation underscores the body's remarkable ability to compensate for the absence of the gallbladder and maintain digestive efficiency. [22]

CHOLECYSTITIS:

Cholecystitis is an inflammatory condition of the gallbladder that is most frequently caused by an obstruction of the cystic duct, typically due to gallstones formed in the gallbladder itself. This blockage prevents bile from exiting the gallbladder, leading to inflammation and, in some cases, infection. When cholecystitis is uncomplicated—that is, not accompanied by additional

severe complications—the prognosis is generally excellent. Treatment, which often involves the surgical removal of the gallbladder (cholecystectomy), is usually successful, and patients can expect to lead a normal life post-surgery. the presence of complications can significantly alter the clinical outlook. For example, if the inflamed gallbladder develops perforations (holes in the gallbladder wall) or progresses to gangrene (tissue death due to insufficient blood supply), the condition becomes much more serious. These complications can lead to widespread infection and sepsis, a life-

threatening response to infection. In such cases, immediate medical attention and intervention are crucial to manage the complications and stabilize the patient's condition, but the prognosis becomes less favourable compared to uncomplicated cases. [23]

EPIDEMIOLOGY:

Cholecystitis, an inflammation of the gallbladder, contributes significantly to cases of abdominal pain worldwide, accounting for approximately 3 to 10% of such incidents. In India alone, the impact of cholecystitis on healthcare facilities was notable in 2015, with an estimated 651,829 emergency department visits and 389,180 hospital admissions directly attributable to this condition. The majority of individuals with gallstones, however, do not experience symptoms. It's estimated that only about 1 to 2% of people with gallstones develop symptoms annually. This relatively low symptomatic rate highlights the fact that while gallstones are common, they do not always lead to complications or discomfort. The incidence and patterns of cholecystitis closely mirror those of cholelithiasis (the formation of gallstones), given the direct relationship between the presence of gallstones and the onset of acute cholecystitis. Gallstones can obstruct the cystic duct, which typically leads to inflammation and, potentially,

to cholecystitis if not promptly treated. This connection underscores the importance of monitoring and managing gallstones to prevent the progression to cholecystitis, particularly in individuals at higher risk due to dietary, genetic, or other health factors.

ETIOLOGY: [24]

Risk factors for calculous cholecystitis include the following:

- Female sex, Obesity, Rapid weight loss, Oral contraceptive pills, Pregnancy, Increasing age.
- Acalculous cholecystitis related to conditions associated with biliary stasis and include the following:
- Critical illness, major surgery or severe trauma, burns, long term parenteral nutrition, prolonged fasting.

Other causes:

- Myocardial infarction, sickle cell disease, salmonella infections, diabetes, patient with AIDS.

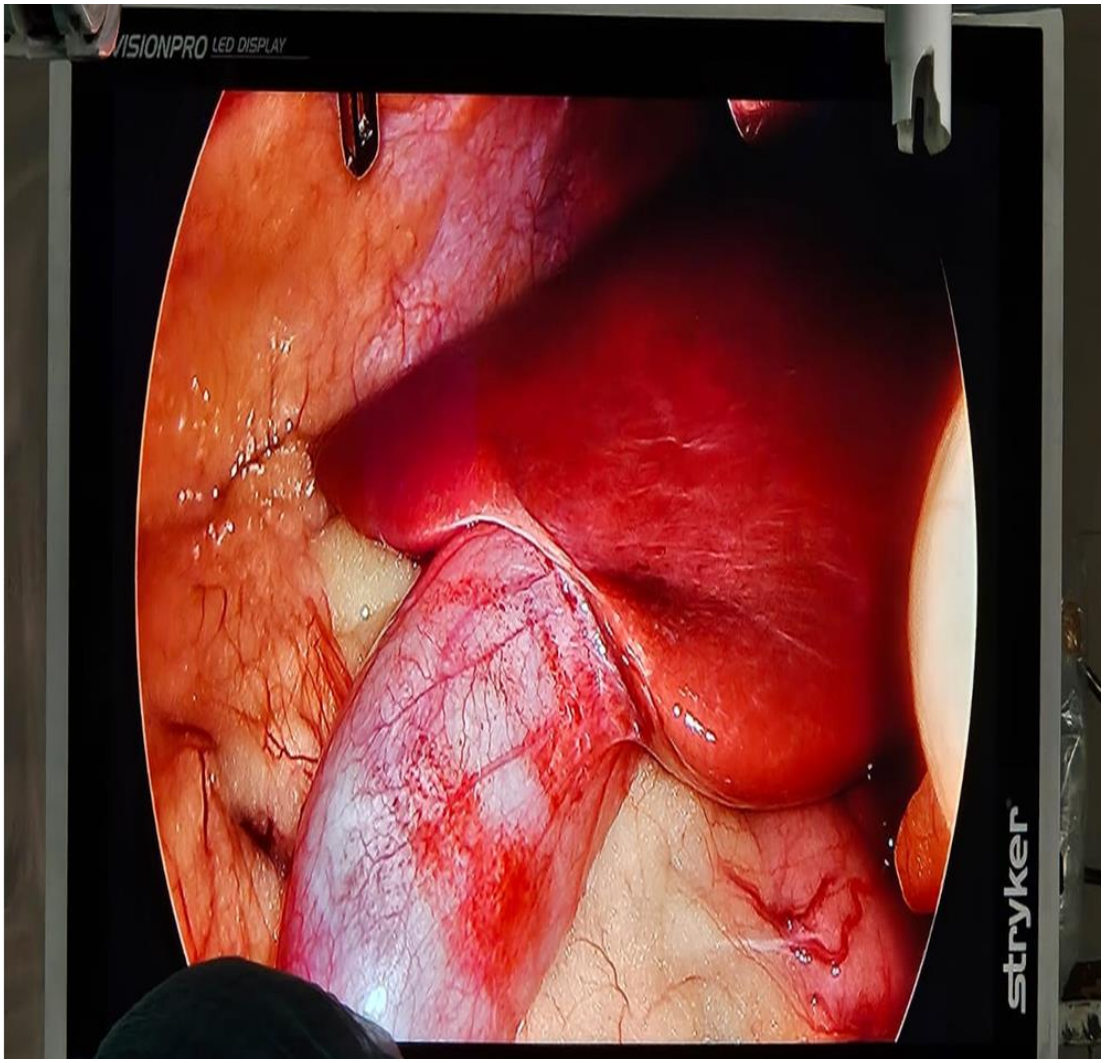


Figure 5: Intra operative picture of acute cholecystitis

ACUTE CALCULOUS CHOLECYSTITIS:

Gallstones are the primary cause of cholecystitis, accounting for about 90% of all cases. These gallstones can obstruct the flow of bile out of the gallbladder, leading to a buildup and thickening of bile within the organ. This blockage results in the gallbladder becoming enlarged, red, and tense, which are typical signs of inflammation. the gallbladder remains sterile, but the stagnant bile and altered conditions within the gallbladder can create an environment conducive to bacterial infection. Common bacterial culprits that infect the inflamed gallbladder include E. coli, Klebsiella, Streptococcus, and Clostridium species. Once the infection sets in, the situation can rapidly worsen. [25]

ACALCULOUS CHOLECYSTITIS:

Acalculous cholecystitis is a form of cholecystitis where no gallstones are present in the biliary ducts. This condition accounts for 5 to 10% of all cholecystitis cases and is notably associated with higher morbidity and mortality rates compared to its calculous counterpart. Acalculous cholecystitis typically occurs in individuals who are critically ill or hospitalized, often presenting in patients who are experiencing severe trauma, undergoing major surgeries, or suffering from burns or serious infections. The pathophysiology of acalculous cholecystitis is different from that of the more common gallstone-related cholecystitis. It often involves factors such as poor blood supply (ischemia) to the gallbladder, infection, and the effects of prolonged fasting or parenteral nutrition, which can lead to bile stasis and gallbladder inflammation. Conditions like vasculitis and the impacts of chemotherapy can also contribute to the development of acalculous cholecystitis by affecting the blood vessels of the gallbladder or altering the immune system's response. Due to its association with critical illnesses and complex medical conditions, acalculous cholecystitis

requires prompt diagnosis and management. The treatment often involves antibiotics, supportive care, and sometimes surgical intervention, depending on the severity and underlying cause of the inflammation. This form of cholecystitis poses a significant challenge in clinical settings, especially in critically ill patients, where the diagnosis may be complicated by the patient's overall condition. The inflammation caused by cholecystitis can also extend beyond the gallbladder itself, affecting the outer covering of the gallbladder and adjacent structures, including the diaphragm. This spread of

inflammation to the diaphragm is often responsible for referred pain to the right shoulder, a symptom frequently reported by patients suffering from acute cholecystitis. This referred pain occurs because the diaphragm shares nerve pathways with the shoulder, specifically the phrenic nerve, which can transmit pain signals to the shoulder area when the diaphragm is irritated.

CHRONIC CHOLECYSTITIS:

Chronic cholecystitis typically develops after repeated episodes of acute cholecystitis and is most commonly associated with gallstones. This condition represents a long-term inflammation of the gallbladder, where the repeated irritation caused by gallstones leads to progressive damage and thickening of the gallbladder walls. In many cases, chronic cholecystitis may be asymptomatic, meaning individuals might not experience noticeable symptoms despite ongoing inflammation. However, it can also present symptoms similar to or more severe than those of acute cholecystitis, such as persistent abdominal pain, particularly in the upper right quadrant, nausea, vomiting, and digestive disturbances, especially after eating fatty foods. chronic cholecystitis can lead to a number of serious complications. [26] For instance, the continuous inflammation can weaken the gallbladder wall, increasing the risk of gangrene and perforation, where holes form in the gallbladder wall leading to leakage of bile into the abdominal cavity, a condition that can cause severe infections and generalized inflammation of the abdomen (peritonitis). Another possible complication is the formation of a fistula, an abnormal connection that can develop between the gallbladder and other digestive organs, which can lead to further complications, such as gallstone ileus if a stone passes into and obstructs the intestines.

The mechanism of damage in chronic cholecystitis starts when a gallstone blocks the cystic duct, the main exit pathway for bile from the gallbladder. This blockage causes bile to accumulate in the gallbladder, leading to increased pressure inside the organ. The concentrated bile and increased pressure, coupled with potential bacterial infection, contribute to the irritation and damage of the gallbladder wall. This continuous cycle of irritation and swelling reduces the normal blood flow to the gallbladder tissue, depriving cells of oxygen and leading to cell death and further inflammation, thereby exacerbating the condition. Prompt treatment, often surgical removal of the gallbladder, is necessary to prevent complications and improve the patient's quality of life.

Figure 6: Cut section of gallbladder showing thickened gallbladder wall

Calculous Biliary Disease

Cholelithiasis is the most common disease of gallbladder and biliary tree, affecting 10% to 15% of the population. Gallstones are generally classified into two major subtypes, cholesterol and pigment stones, depending on the principal solute that precipitates into a stone. More than 70% of gallstones in the United States are formed by precipitation of cholesterol and calcium, and pure cholesterol stones account for less than 10%. Pigment stones can be divided into black stones, as seen in haemolytic conditions and cirrhosis, and brown stones, which tend to be found in the bile ducts and are thought to be secondary to infection. The difference in colour arises from incorporation of cholesterol into the brown stones. Because black pigment stones occur in haemolytic states from concentration of bilirubin, they are found almost exclusively in the gallbladder. Alternatively, brown stones can occur within the biliary tree and suggest a disorder of biliary motility and associated bacterial infection. Four major factors explain most gallstone formation: supersaturation of secreted bile, concentration of bile in the gallbladder,

crystal nucleation, and gallbladder dysmotility. High concentrations of cholesterol and lipid in bile secretion from the liver constitute one predisposing condition to cholesterol stone formation, whereas increased haemoglobin processing is seen in most patients with pigment stones. Once in the gallbladder, bile is concentrated further through the absorption of water and sodium, increasing the concentrations of the bile solutes and calcium. Bile salts act to solubilize cholesterol. With respect to cholesterol stones, cholesterol precipitates out into crystals when the concentration in the gallbladder vesicles exceeds the solubility of cholesterol, Crystal formation is further accelerated by pronucleating agents, including glycoproteins and immunoglobulins. Finally, abnormal gallbladder motility can increase stasis in the gallbladder, allowing more time for solutes to precipitate in the gallbladder. Therefore, increased stone formation can be seen in conditions associated with impaired gallbladder emptying, such as in prolonged fasting states, with use of total parenteral nutrition, after vagotomy, and with use of somatostatin analogues.

Acute cholecystitis is the result of a blockage of the cystic duct and is called acute calculous cholecystitis when the blockage is by a stone. In chronic cholecystitis or biliary colic, the blockage is temporary and repetitive, while in acute cholecystitis, the blockage does not resolve, leading to inflammation with oedema and subserosal haemorrhage. Obstruction is followed by infection of the stagnant pool of bile. Without resolution of the obstruction, the gallbladder will progress to ischemia and necrosis. Eventually, acute cholecystitis becomes acute gangrenous cholecystitis and, when complicated by infection with a gas-forming organism, acute emphysematous cholecystitis

CLINICAL FEATURES & DIAGNOSIS:

The inflammatory changes associated with acute cholecystitis typically present as fever and right upper quadrant pain, often accompanied by nausea and vomiting. During physical examination, patients commonly exhibit tenderness upon palpation, guarding in the right upper quadrant, and sometimes a positive Murphy's sign, which indicates gallbladder inflammation. To systematically evaluate the severity of cholecystitis, several grading systems have been developed, including the widely recognized Tokyo Guidelines and the American Association for the Surgery of Trauma (AAST) Emergency General Surgery (EGS) guidelines. The AAST EGS framework categorizes acute cholecystitis into five grades, ranging from grade 1, characterized by localized inflammation, to grade 5, which involves more severe complications such as pericholecystic abscess, bilio-enteric fistula, and peritonitis. Similarly, the Tokyo Guidelines assess the systemic impact of cholecystitis, including potential organ failure, thus aiding in the management and treatment decision-making based on the disease's severity. Supportive diagnostic markers such as mild elevations in alkaline phosphatase, bilirubin, transaminase levels, and leucocytosis further corroborate the diagnosis of acute cholecystitis. However, profound jaundice is uncommon in straightforward cases of acute cholecystitis due to the absence of common bile duct obstruction. Such a presentation should prompt consideration of cholangitis or Mirizzi syndrome, where inflammation or a gallstone lodged at the neck of the gallbladder induces inflammation in the adjacent biliary system, potentially leading to obstruction of the common hepatic duct.

Transabdominal ultrasonography stands as a sensitive, cost-effective, and reliable diagnostic tool for acute cholecystitis, boasting a sensitivity of 85% and a specificity of 95%. This imaging modality excels in identifying gallstones and can also reveal other key indicators of cholecystitis such as pericholecystic fluid, gallbladder wall thickening, and even a sonographic Murphy sign, which specifically documents tenderness over the gallbladder. Typically, a combination of a thorough history and physical examination, supported by laboratory studies and an ultrasound examination, is sufficient to diagnose acute cholecystitis. In cases where the diagnosis remains uncertain, a HIDA scan can be employed to demonstrate obstruction of the cystic duct, which definitively confirms acute cholecystitis. If the gallbladder fills during a HIDA scan, it effectively rules out cholecystitis. While a CT scan can display similar findings to ultrasound, such as pericholecystic fluid and gallbladder wall thickening, it is less sensitive than ultrasound for diagnosing acute cholecystitis and might be used in scenarios where additional anatomical details are required or when complications such as emphysematous changes are suspected.

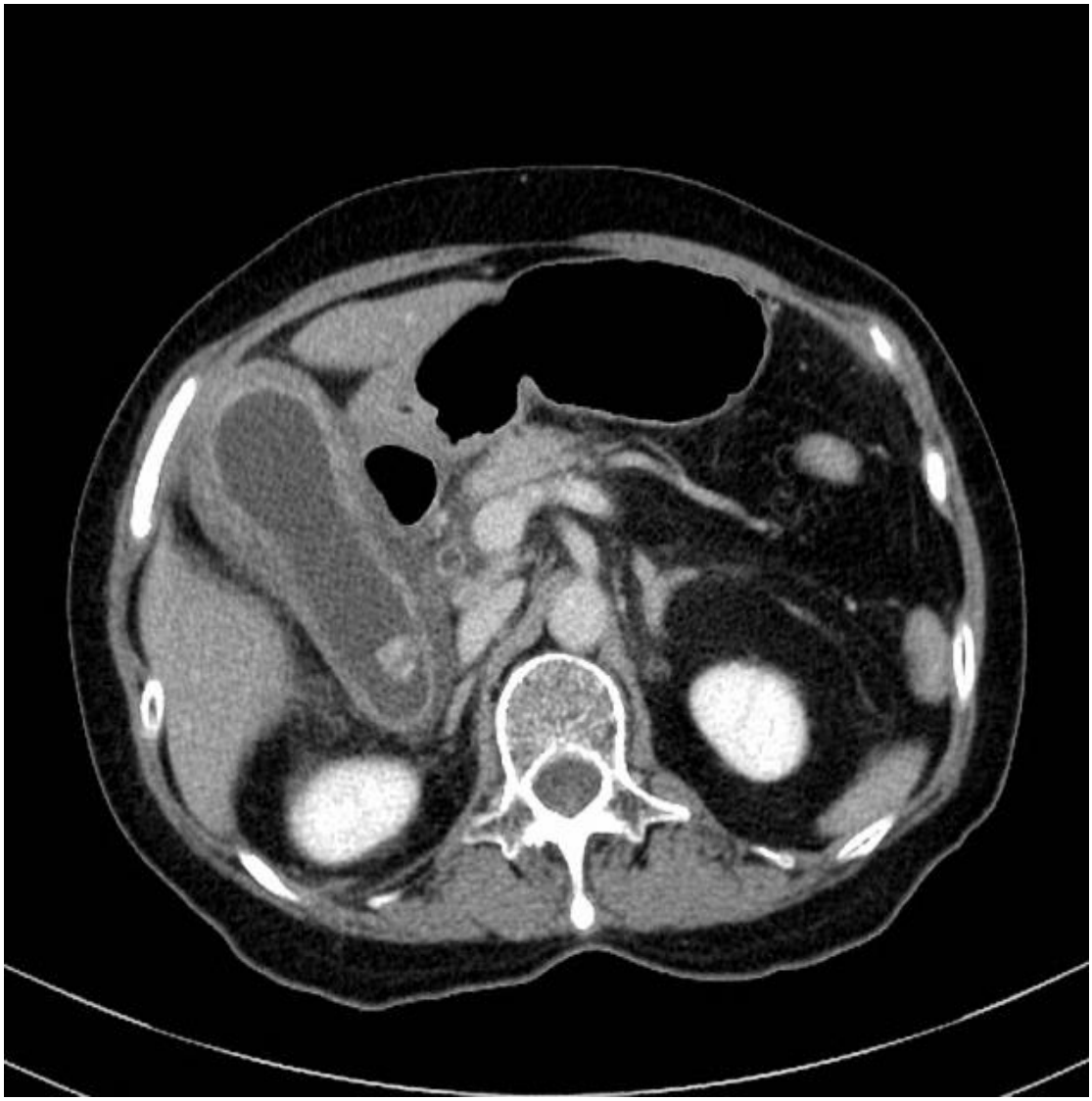


Figure 7: CT image in axial plane showing thickened gall bladder wall with pericholecystic fluid.

Figure 8: CT image in sagittal plane showing thickened GB wall with pericholecystic fluid.

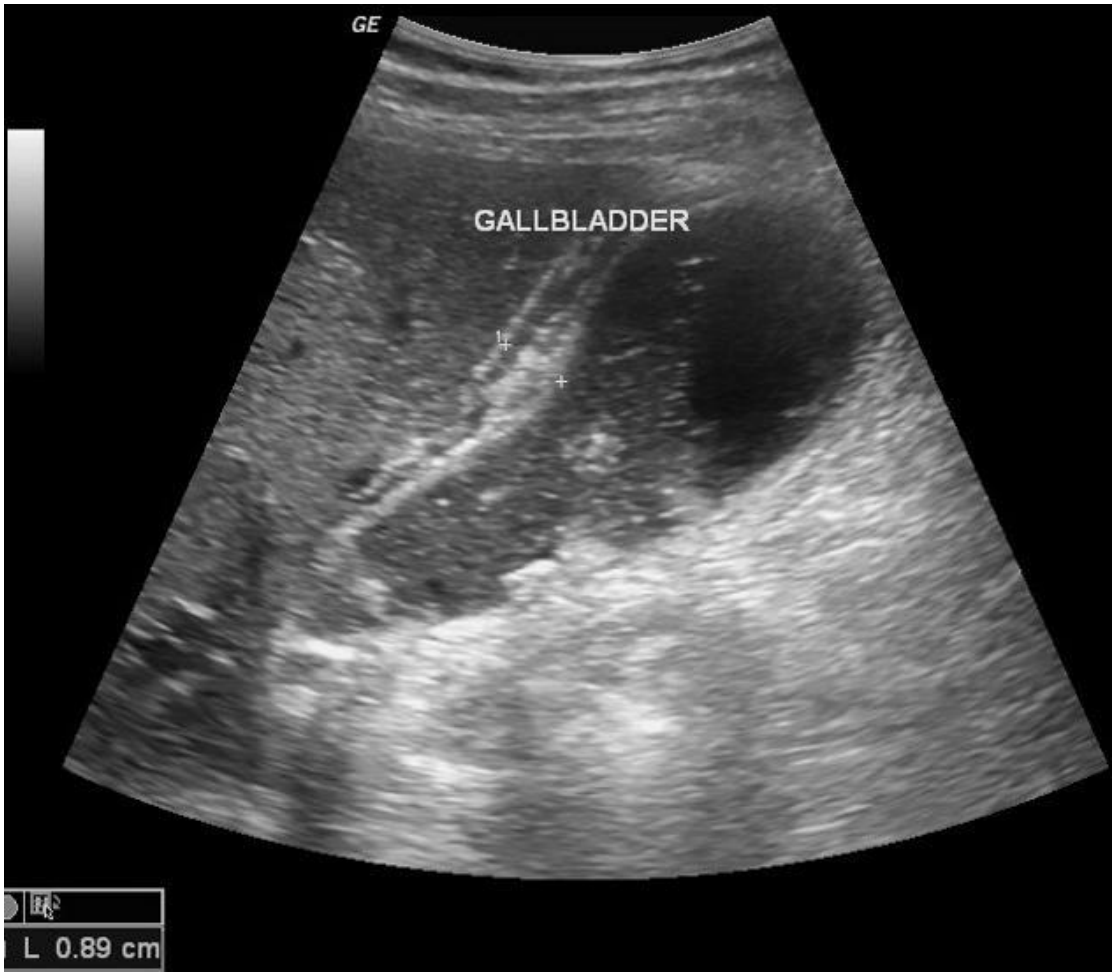


Figure 9: ACUTE CALCULOUS CHOLECYSTITS: USG of the right upper quadrant in patient reveals marked thickening of gall bladder wall with pericholecystic fluid.

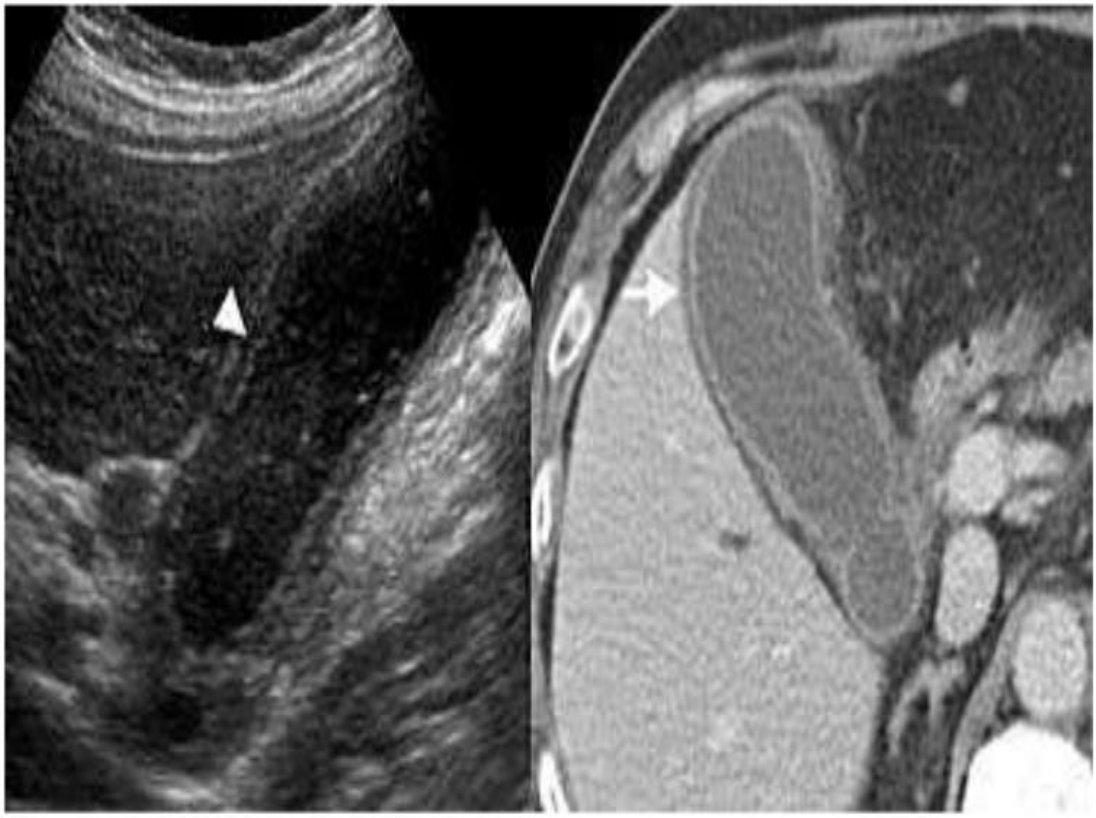


Figure 10: CT IMAGES OF ACUTE CHOLECYSTITIS

CHOLECYSTECTOMY:

Cholecystectomy, [27] the surgical removal of the gallbladder, is a commonly employed treatment for various gallbladder-related issues, including symptomatic gallstones. This surgery is pivotal in managing symptoms and preventing future complications such as pancreatitis and gallbladder cancer. There are two main types of cholecystectomies: laparoscopic cholecystectomy and open cholecystectomy. Laparoscopic cholecystectomy is the standard, minimally invasive approach that uses small incisions to remove the gallbladder, offering benefits like quicker recovery and less postoperative pain. Open cholecystectomy involves a larger incision and is generally used when laparoscopic surgery is not possible, or complications arise. The surgery is indicated for conditions such as acute or chronic cholecystitis, biliary colic, risk of gallbladder cancer, and pancreatitis caused by gallstones blocking the common bile duct. Performing a cholecystectomy can significantly improve the patient's quality of life by preventing the recurrence of painful and potentially life-threatening conditions.

LAPAROSCOPIC CHOLECYSTECTOMY:

Laparoscopic cholecystectomy has largely become the preferred technique for addressing gallstones and inflammation of the gallbladder, replacing the older, more invasive open cholecystectomy for most patients, unless there are specific reasons not to use this method. The key advantage of the laparoscopic approach is its minimal invasiveness, which generally leads to fewer infections, quicker recovery times, and less post-surgical pain for patients compared to the open method. During a laparoscopic cholecystectomy, small incisions are made in the patient's abdomen. These incisions are used to insert narrow tubes called ports, through which surgical instruments and a small camera are introduced into the abdominal cavity. This camera is crucial as it projects a magnified image of the internal organs onto a monitor, allowing the surgeon to see the operating area clearly. By watching this monitor, the surgeon can manipulate the instruments precisely, performing the surgery without the need for a large incision. The surgery begins with the patient under anaesthesia. An initial incision is made at the belly button, and a device known as a Veress needle or the Hasson technique is used to enter the abdominal cavity. The cavity is then inflated with carbon dioxide gas, which creates enough space for the surgeon to work. The camera is inserted through the belly button

to provide a clear view, and additional ports might be placed under the ribs to facilitate the use of surgical tools. The surgeon identifies and secures the gallbladder, carefully manipulating it to expose and access the critical area known as Calot's triangle. This area is where the cystic duct and cystic artery are located. These structures are then clipped to prevent bleeding and bile leakage and cut to detach the gallbladder. Finally, the gallbladder is removed through one of the ports. [28]

LAPAROSCOPIC CHOLECYSTECTOMY

In recent years, a more advanced technique known as Laparoendoscopic Single-Site Surgery (LESS) or Single Incision Laparoscopic Surgery (SILS) has been developed. This technique further reduces the invasiveness of the procedure by using only one incision in the navel, through which all surgical instruments are inserted. This not only minimizes the number of incisions but also effectively conceals any surgical scarring within the navel, leaving virtually no visible marks post-surgery. This approach can be particularly appealing for patients concerned about aesthetics, as it offers an almost scar-free result while potentially reducing recovery time.

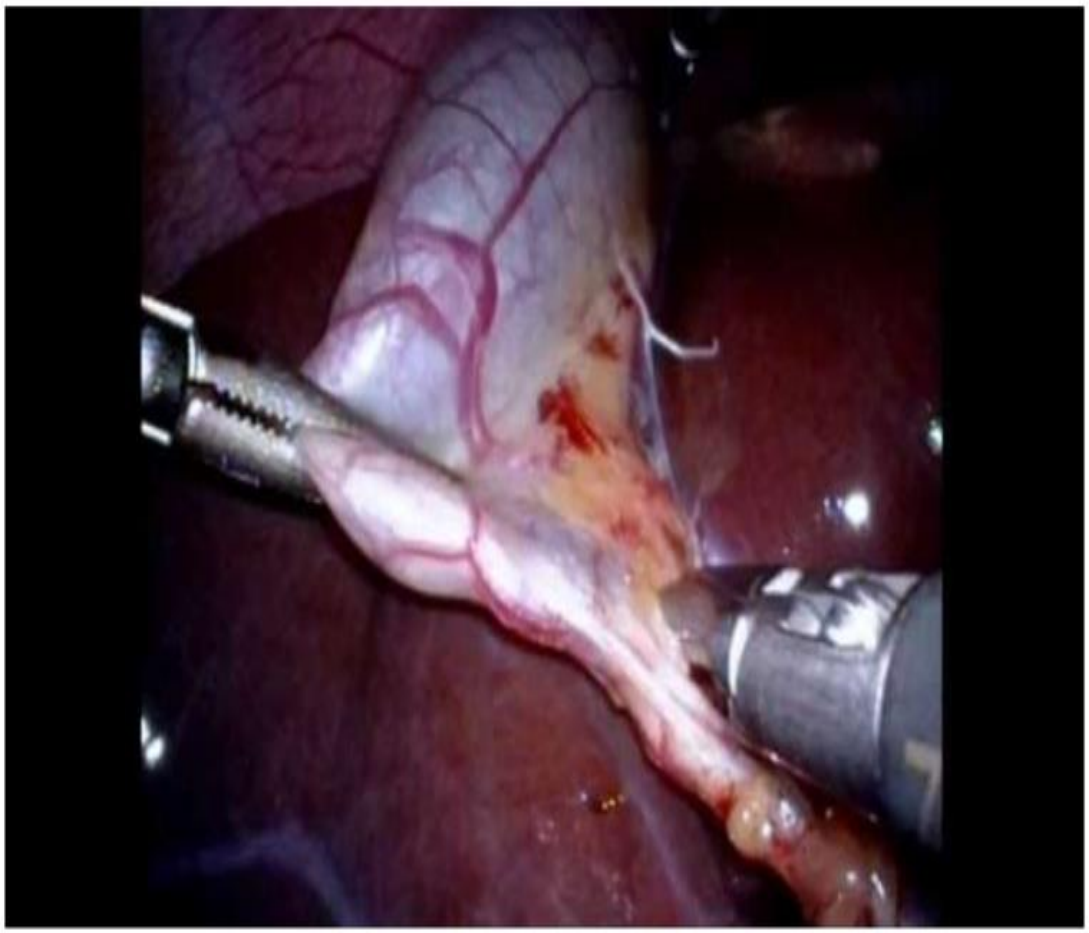


Figure 11: Intraoperative image of Laparoscopic Cholecystectomy

OPEN CHOLECYSTECTOMY:

Open cholecystectomy is a surgical method used to remove the gallbladder, typically reserved for specific situations where laparoscopic cholecystectomy is not feasible or has failed. Such situations might include cases where a patient's severe systemic illness makes the standard laparoscopic approach unsuitable, particularly if the patient cannot tolerate pneumoperitoneum—the insufflation of carbon dioxide gas into the abdomen required for laparoscopic procedures. Open cholecystectomy is also used during certain complex surgeries such as part of a liver transplant. [29]

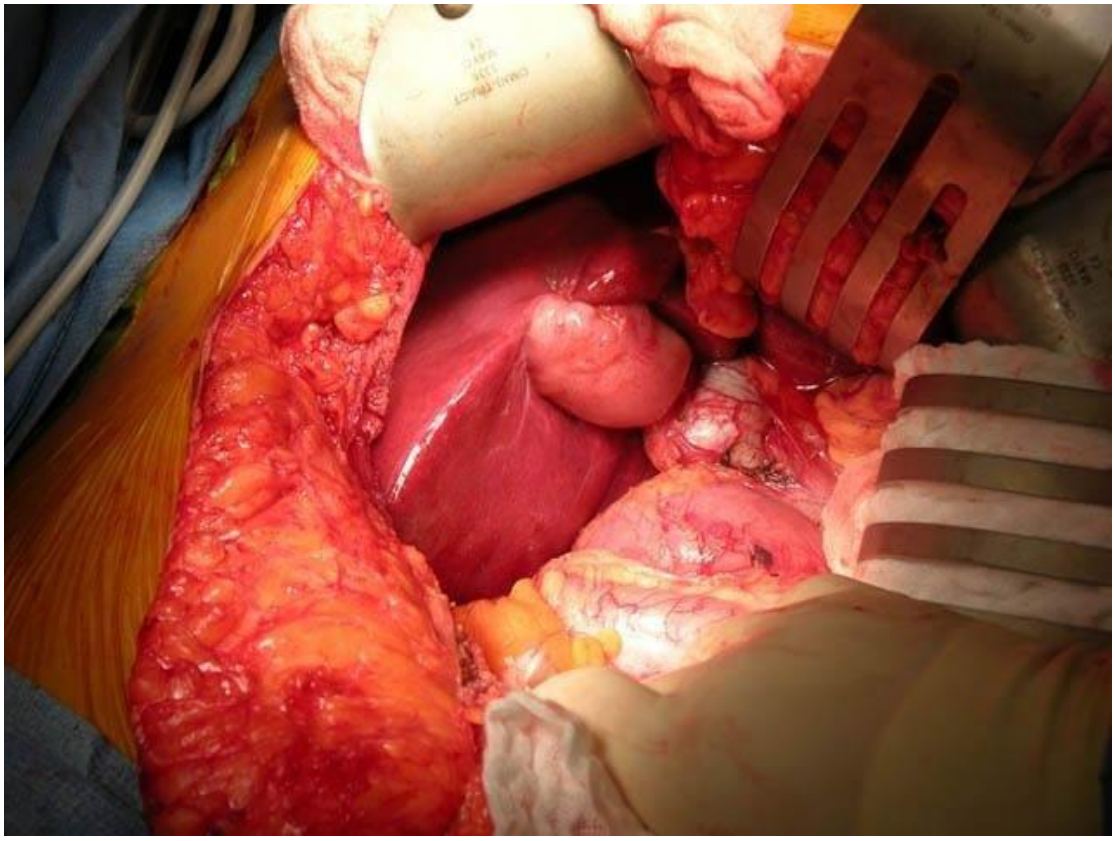


Figure 12: Visual representation of Open Cholecystectomy

OPEN EXPOSURE FOR SURGICAL CHOLECYSTECTOMY

During an open cholecystectomy, a surgical incision about 10 to 15 cm long is made just below the edge of the right rib cage. The liver is carefully retracted upwards to allow surgeons clear access to the gallbladder. The surgery typically involves a top-down approach where the gallbladder is separated from the liver using tools like electrocautery, which uses electrically generated heat to cut through tissue and seal blood vessels because it involves a larger incision, open cholecystectomy is associated with more significant postoperative pain and a higher risk of complications such as wound infections and incisional hernias compared to the laparoscopic method. Due to these factors, open cholecystectomy is generally chosen only under circumstances where less invasive techniques are unsuitable, ensuring that it remains an important option in the surgical management of gallbladder diseases.

Bhattacharya et al. (2002)[30] evaluated the safety and feasibility of urgent versus interval laparoscopic cholecystectomy for acute cholecystitis during the index admission between October 2000 and October 2001. Their study found that earlier surgery reduced the total hospital stay without impacting operating times or postoperative stays, thus benefiting patients and the healthcare system.

Kolla et al. (2004)[31] in their prospective randomized study between January 2001 and November 2002, compared early laparoscopic cholecystectomy within 24 hours of admission to delayed surgery after initial conservative treatment. Their findings supported that early cholecystectomy is safe and feasible, significantly reducing hospital stays and should be considered if performed within 72 to 96 hours after symptom onset.

Lau et al. (2006)[32] conducted a meta-analysis to assess the outcomes of early versus delayed-interval laparoscopic cholecystectomy for acute cholecystitis, using studies published between January 1988 and June 2004. Their objectives were to compare the efficacy and safety of the two approaches based on randomized clinical trials. They concluded that early laparoscopic cholecystectomy reduces total hospital stays and readmission rates due to recurrent acute cholecystitis, making it a more cost-effective approach.

Siddiqui et al. (2008)[33] performed a meta-analysis of randomized clinical trials comparing early versus delayed laparoscopic cholecystectomy conducted between 1987 and 2006. They reported that early cholecystectomy significantly reduces total hospital stays at the expense of a slightly longer operation time, without significant differences in conversion rates or complications.

Uysal et al. (2016)[34] conducted a retrospective, observational, multicentred study from January 2010 to March 2016, comparing early and delayed laparoscopic cholecystectomy. They observed no significant differences in complication rates or operation times between early and delayed procedures but noted shorter hospital stays and lower 30-day readmission rates with early cholecystectomy.

Özkardeş et al. (2014)[35] and colleagues explored the economic and clinical differences between performing laparoscopic cholecystectomy (LC) early versus delaying the procedure. Their findings indicated that the duration of the surgery and the likelihood of needing to switch to an open surgical method did not differ significantly between the two groups. However, they noted that undergoing the procedure earlier resulted in shorter stays at the hospital and reduced overall healthcare costs, despite a slightly higher occurrence of complications.

Chhajed et al. (2018)[36] focused on comparing the outcomes of early versus delayed laparoscopic cholecystectomy (LC) for treating acute cholecystitis. The study included a total of 50 patients diagnosed with this condition. They observed a markedly lower rate of conversion to open surgery among patients who underwent early LC, fewer post-operative complications, significantly shorter hospital stays, and quicker return to normal activities for those who had early surgery.

Borzellino et al. (2021)[37] and his research team conducted a meta-analysis to explore the impact of surgery timing on post-operative outcomes for patients with acute calculous cholecystitis. They found that performing an immediate cholecystectomy, within the first 24 hours of admission, did not show a significant reduction in post-operative complications when compared to surgeries performed later, although surgeries conducted within 72 hours of symptom onset were notably beneficial.

Mannam et al. (2023)[38] reviewed studies comparing laparoscopic cholecystectomy (LC) and open cholecystectomy (OC) in the treatment of acute cholecystitis, discussing the advantages and limitations of both techniques without a clear consensus on the superiority of one over the other.

Güneş et al. (2023)[39] focused on determining the best timing for performing laparoscopic cholecystectomy (LC) in patients with gallbladder issues, strongly recommending immediate surgical intervention after diagnosis to reduce hospital stay lengths and minimize complications while waiting for the surgery.

MATERIAL AND METHODS

MATERIALS AND METHOD

STUDY AREA- Department of General Surgery, Santosh medical college and hospital, Ghaziabad, UP.

STUDY DESIGN- Hospital based observational study

DURATION OF STUDY- 18 months

SAMPLE SIZE- 72 (36 in group 1; 36 in group 2)

$$n_1 = \frac{(\sigma_1^2 + \sigma_2^2 / \kappa)(z_{1-\alpha/2} + z_{1-\beta})^2}{\Delta^2}$$

$$n_2 = \frac{(\kappa * \sigma_1^2 + \sigma_2^2)(z_{1-\alpha/2} + z_{1-\beta})^2}{\Delta^2}$$

The notation for the formulae are:

n_1 = sample size of Group 1
n_2 = sample size of Group 2
σ_1 = standard deviation of Group 1
σ_2 = standard deviation of Group 2
Δ = difference in group means
κ = ratio = n_2/n_1
$Z_{1-\alpha/2}$ = two-sided Z value (eg. Z=1.96 for 95% confidence interval).
$Z_{1-\beta}$ = power

Sample Size For Comparing Two Means

Input Data

Confidence Interval (2-sided)	95%		
Power	80%		
Ratio of sample size (Group 2/Group 1)	1		
	Group 1	**Group 2**	**Difference***
Mean	90	100	-10
Standard deviation	15	15	
Variance	225	225	

Sample size of Group 1	36
Sample size of Group 2	36
Total sample size	72

*Difference between the means

Results from OpenEpi, Version 3, open source calculator--SSMean
Print from the browser with ctrl-P
or select text to copy and paste to other programs.

INCLUSION CRITERIA

Patients coming to the Emergency/Outpatient Department of Santosh hospital Ghaziabad within 96 hrs of acute symptoms were diagnosed as a case of acute cholecystitis on the basis of clinical, laboratory-

- acute upper abdominal pain,
- right hypochondrial tenderness and/or guarding,
- fever >37.5∘ C and/or,
- white blood cell counts greater than 10 × 109
- ultrasonographic criteria (GB wall thickened > 4 mm and oedematous
- gallbladder (GB), pericholecystic oedema, positive sonographic Murphy's sign, and gallstones).

EXCLUSION CRITERIA:

Patients with

- acute symptoms present for >96 hours prior to admission,
- previous upper abdominal surgery,
- patients unfit for general anaesthesia,
- coexisting common bile duct (CBD) stones as suggested by history of jaundice or fever with chills, icterus, raised alkaline phosphatase,
- ultrasonographic evidence of CBD calculus,
- coexistent acute cholangitis, or pancreatitis were excluded from the study.

Methodology –

After taking the required consent, patients were assessed under the following

(Annexure 1):

- History
- Symptoms and signs
- Lab Investigations
- Ultrasound finding

In this study, a total of 72 patients diagnosed with acute calculous cholecystitis and indicated for laparoscopic cholecystectomy were randomly assigned into two groups to compare the outcomes of early versus interval laparoscopic cholecystectomy. Using a simple randomization technique, patients were evenly divided into Group 1 (early laparoscopic cholecystectomy) and Group 2 (interval laparoscopic cholecystectomy), with 36 patients in each group. Randomization was performed to minimize selection bias and ensure that both groups were comparable in terms of baseline characteristics such as age, gender, clinical presentation, and comorbidities.

DATA MANAGEMENT AND ANALYSIS

- . We examine a sample size of 36 patients in each group, with EC being performed within 7 days of admission and DC conducted about 6 weeks after the initial episode. This study also considers broader outcomes such as surgical safety, efficacy, healthcare costs, workdays lost, and overall quality of life. This recent endeavour includes data from new randomized controlled trials that compare early and late cholecystectomies, providing a comprehensive analysis to help resolve the ongoing debate about the best surgical timing for treating acute cholecystitis. Through this study, we aim to contribute to the evolving guidelines on managing this common yet complex condition, ensuring that treatment protocols are both effective and patient centred.
- The data was collected and entered in MS Excel 2010. Different statistical analyses were performed using Stata MP-17.
- The one-sample Kolmogorov-Smirnov test was employed to determine whether the data sets differed from a normal distribution or not. Normally distributed data were analysed using parametric tests, and non-normally distributed data were analysed using non-parametric tests.
- Descriptive statistics was calculated for qualitative and categorical variables. Graphical representation of the variable was shown to understand the results clearly and to measure the association for categorical dataset was analysed using ChiSquare test. Independent T-test or student t-test was applied to measure the mean difference between two groups. Correlation was estimated to measure the strength of relationship between two or more quantitative variables.
- If p value <0.05, considered as statistically significant and if p value>0.05, then it is statistically insignificant.

RESULTS

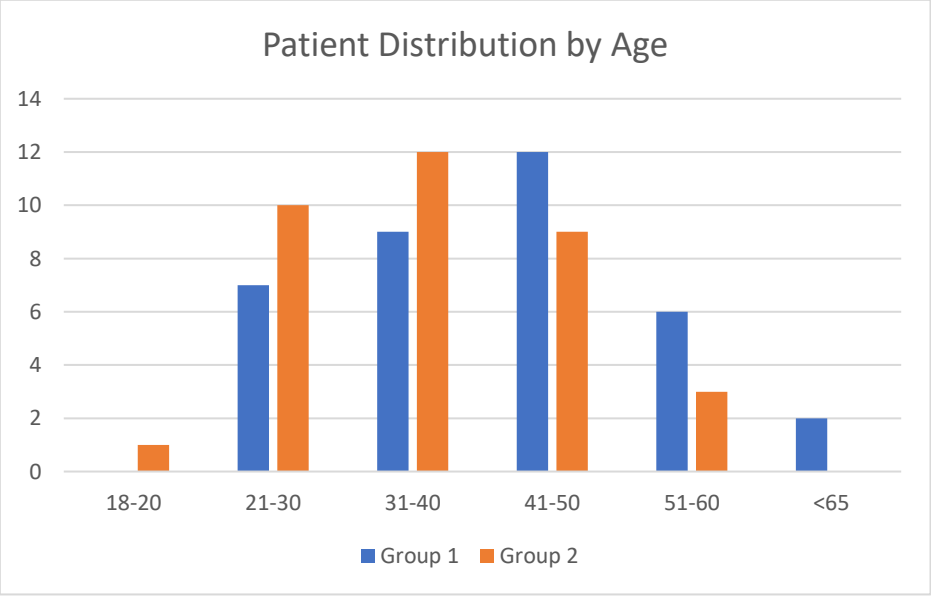
RESULT

Table 1: Distribution of study subjects according to Age

	Group		
Age	**Group 1**	**Group 2**	**Total**
18-20	0	1	1
21-30	7	10	17
31-40	9	12	21
41-50	12	9	21
51-60	6	3	9
≤65	2	1	3
Total	**36**	**36**	**72**
Mean ± SD	**41.7 ± 11.8**	**37.8 ± 10.7**	

χ^2=3.72, p=0.59

Table 1 presents the age distribution of 72 patients undergoing laparoscopic cholecystectomy, categorized by surgery timing. The mean age for Group 1 was 41.7 years (SD = 11.8), and for Group 2, it was 37.8 years (SD = 10.7), with most patients in both groups aged 31 to 50. Chi-square analysis (χ^2 = 3.72, p = 0.59) indicated no statistically significant difference in age distribution between the groups and was not a confounding factor in outcome comparisons.



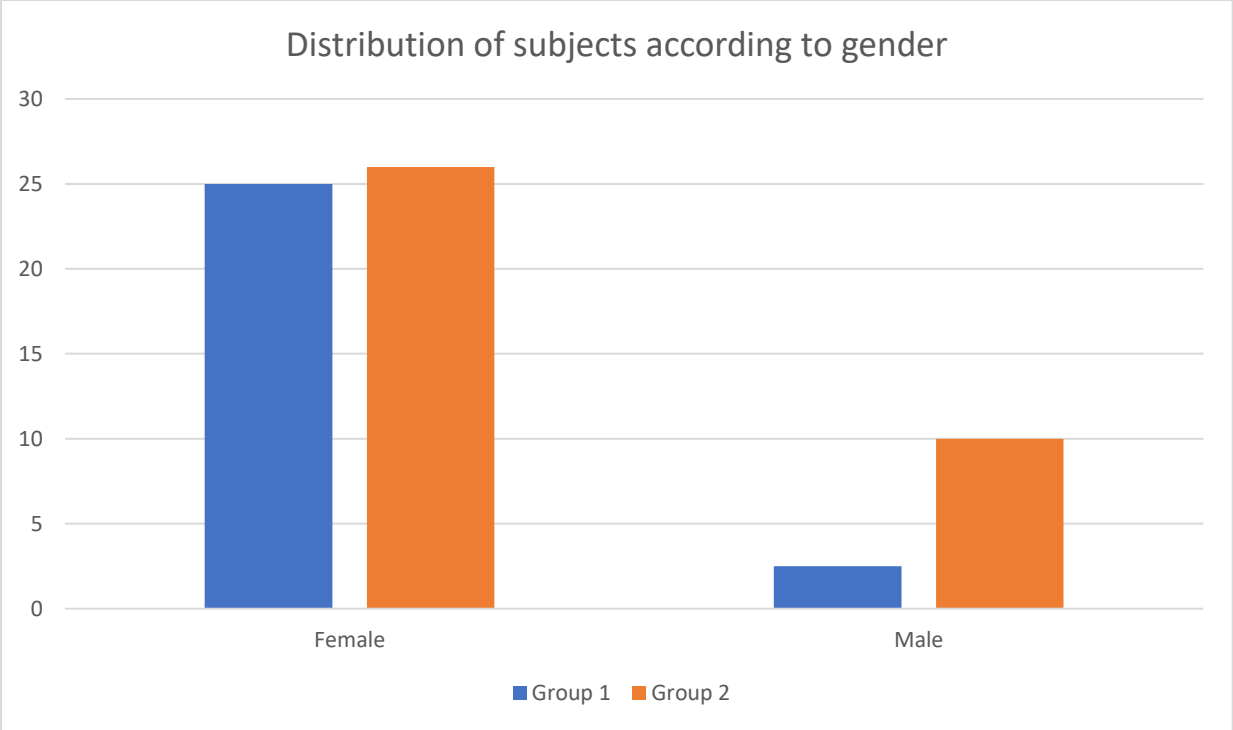
"Graph 1: Distribution of study subjects according to Age"

Table 2: Distribution of study subjects according to gender

	Group		
GENDER	**Group 1**	**Group 2**	**Total**
F	25	26	51
M	11	10	21
Total	**36**	**36**	**72**

χ^2=0.0672, p=0.795

Table 2 presents the gender distribution across both groups. The chi-square test (χ^2 = 0.0672, p = 0.795) revealed no statistically significant difference in gender distribution between the groups, indicating that gender was not a confounding factor in outcome comparisons.



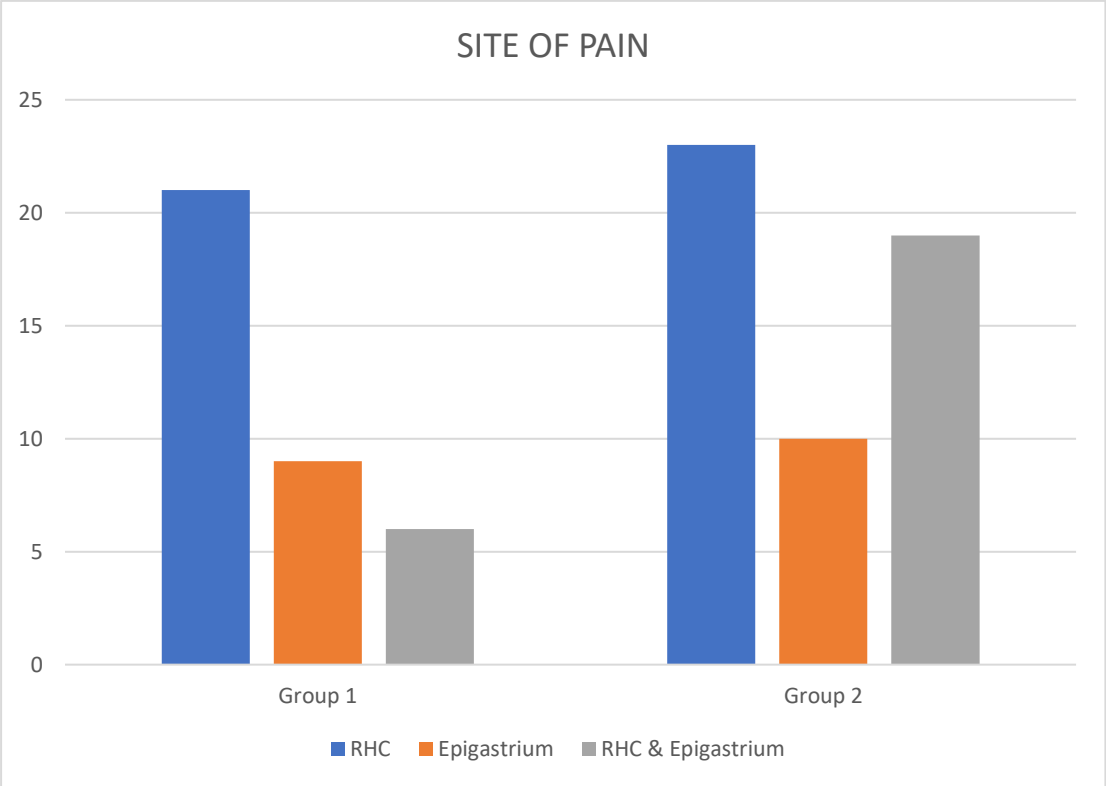
"Graph 2: Distribution of study subjects according to gender"

Table 3: Distribution of study subjects according to site of pain

	GROUP		
SITE OF PAIN	**GROUP 1**	**GROUP 2**	**TOTAL**
RHC	21	23	44
EPIGASTRIUM	9	10	19
RHC & EPIGASTRIUM	6	3	9
Grand Total	**36**	**36**	**72**

χ^2=1.14, p-value = 0.56

Table 3 presents the distribution of pain sites between the two groups. Most subjects reported Right hypochondrium (RHC) pain, followed by Epigastric pain, with some individuals experiencing pain in both areas. Chi-square analysis (χ^2 = 1.14, p = 0.56) revealed no statistically significant difference in pain site distribution, though a trend toward variability was observed.

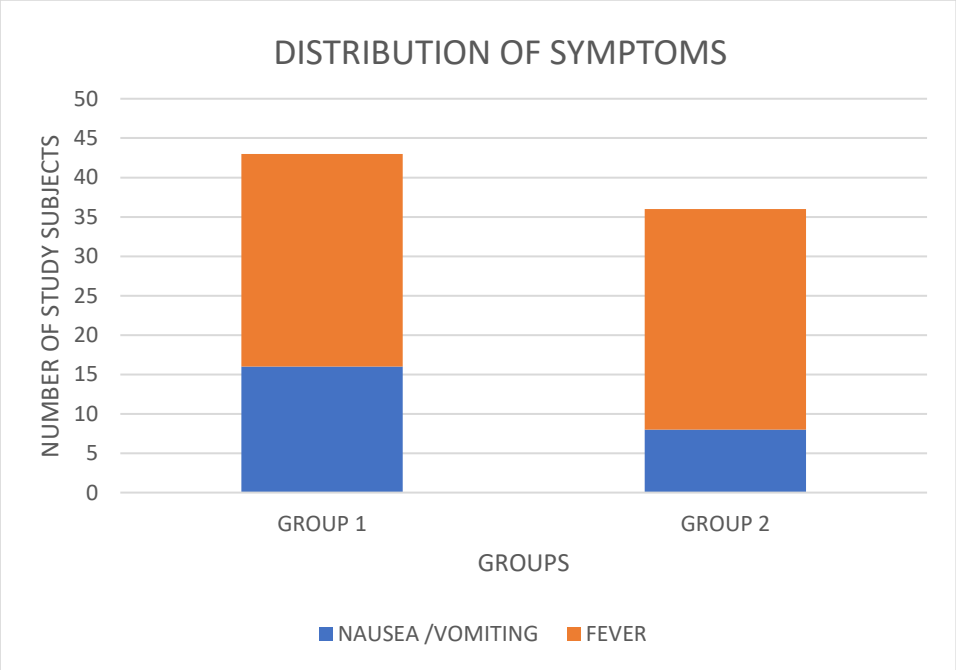


"Graph 3: Distribution of study subjects according to site of pain"

Table 4: Distribution of study subjects according to Symptoms

		Groups			
Symptoms		**Group 1**	**Group 2**	**Total**	**χ^2 & p value**
Nausea/vomiting	Yes	16	8	24	χ^2=3.06, p=0.08
	No	20	28	48	
	Total	36	36	72	
FEVER	Yes	27	28	55	χ^2=0, p=>0.05
	No	9	8	17	
	Total	36	36	72	

In a comparative study analyzing the prevalence of various symptoms among two distinct groups, the data revealed the following patterns: For nausea and vomiting, Group 1 reported 16 cases while Group 2 had 8, totaling 24 cases; this yielded a chi-square value of 3.06 with a p-value of 0.08, suggesting a trend toward significance. Fever was prevalent, observed in 27 cases in Group 1 and 28 in Group 2, totaling 55 cases, suggesting a similar distribution across both groups. The total number of participants was 72 in each symptom. These results reflect symptom distribution and potential clinical implications for both groups.



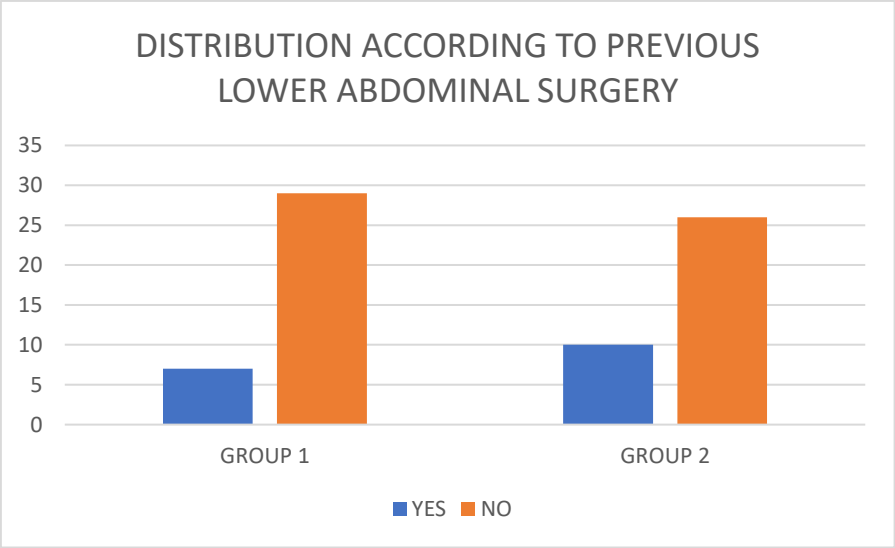
"Graph 4: Distribution of study subjects according to Symptoms"

Table 5: Distribution of study subjects according to previous lower abdominal surgery

	Group		
Previous abdominal surgery	**Group 1**	**Group 2**	**Total**
Yes	7	10	17
No	29	26	55
Total	**36**	**36**	**72**

χ^2=0.31, p=0.57

In this table, the prevalence of previous abdominal surgery among patients was analyzed across two groups. Group 1 consisted of 36 patients, out of which 7 had a history of previous abdominal surgery. Conversely, Group 2, also comprising 36 patients, had a higher incidence, with 10 patients reporting prior abdominal surgeries. Overall, out of the total 72 participants in the study, 17 had undergone previous abdominal surgeries, while 55 had not. This distribution highlights different surgical history profiles between the two groups. This indicates that there is no statistically significant difference between Group 1 and Group 2 regarding the history of previous lower abdominal surgery. The observed differences between groups (7 in Group 1 vs. 10 in Group 2 having previous surgery) are likely due to chance.



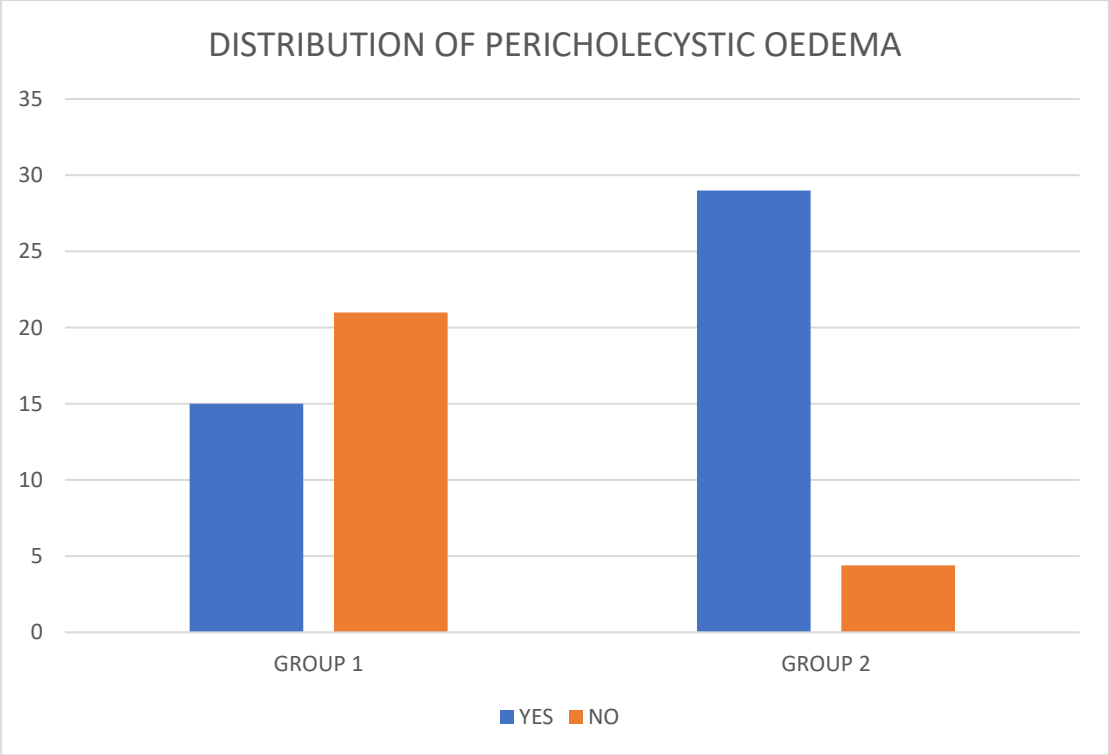
"Graph 5: Distribution of study subjects according to previous lower abdominal surgery"

Table 6: Distribution of study subjects according to peri cholecystic oedema in USG findings.

	Group		
Pericholecystic oedema	**Group 1**	**Group 2**	**Total**
Yes	15	29	44
No	21	7	28
Total	**36**	**36**	**72**

χ^2=9.88, p=0.0017

Table 6 presents the distribution of study participants with respect to pericholecystic oedema in the two groups. In Group 1 and Group 2 have 15 and 29 participants had pericholecystic oedema respectively. A chi-square analysis revealed a value of 9.88 (p = 0.001), indicating a statistically significant difference between the groups. These findings suggest that pericholecystic oedema is significantly more prevalent in Group 2, potentially associated with the condition specific to this group.



"Graph 6: Distribution of study subjects according to pericholecystic oedema/

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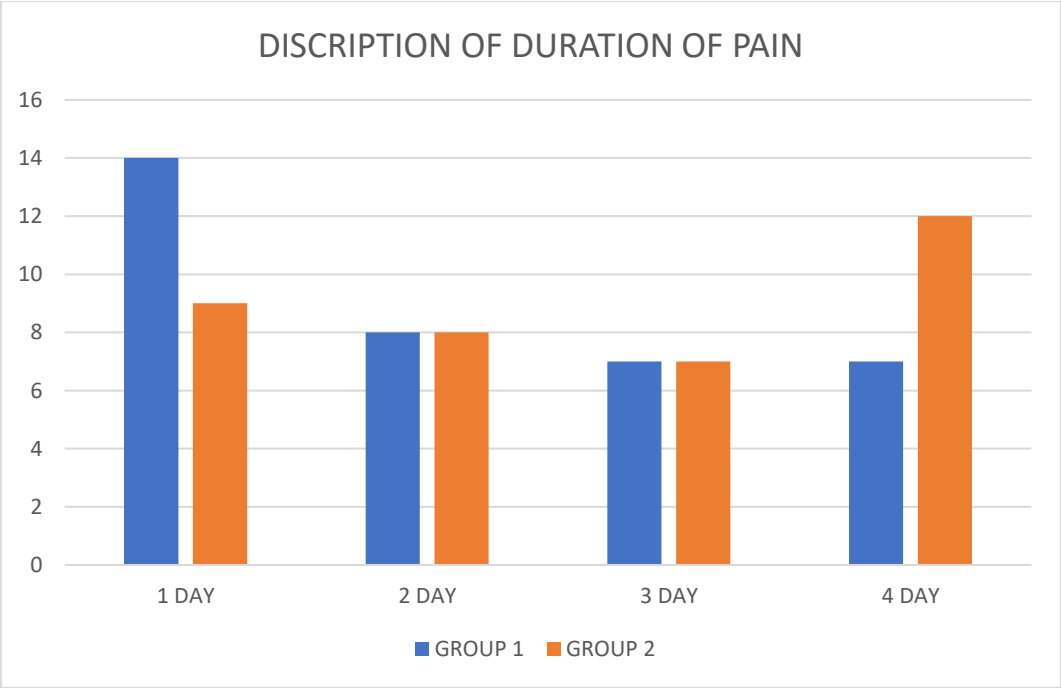
able 7: Descriptive statistics of duration of pain (days)

DURATION OF PAIN (DAYS)	Group 1	Group 2	Total
1	14	9	23
2	8	8	16
3	7	7	14
4	7	12	19
TOTAL	36	36	72

Chi-square statistic: 2.40; **p-value**: 0.493

Table 7 summarized the descriptive statistics for the duration of pain experienced by participants was statistically comparable across both groups. The data suggests that the groups are similar regarding the duration of pain experienced. Thus, any observed differences in clinical outcomes or other parameters between these groups are unlikely to be attributed to differences in pain duration alone. Above specified data reveals chi square of 2.40 and p value of 0.493, suggesting no statistical significance.

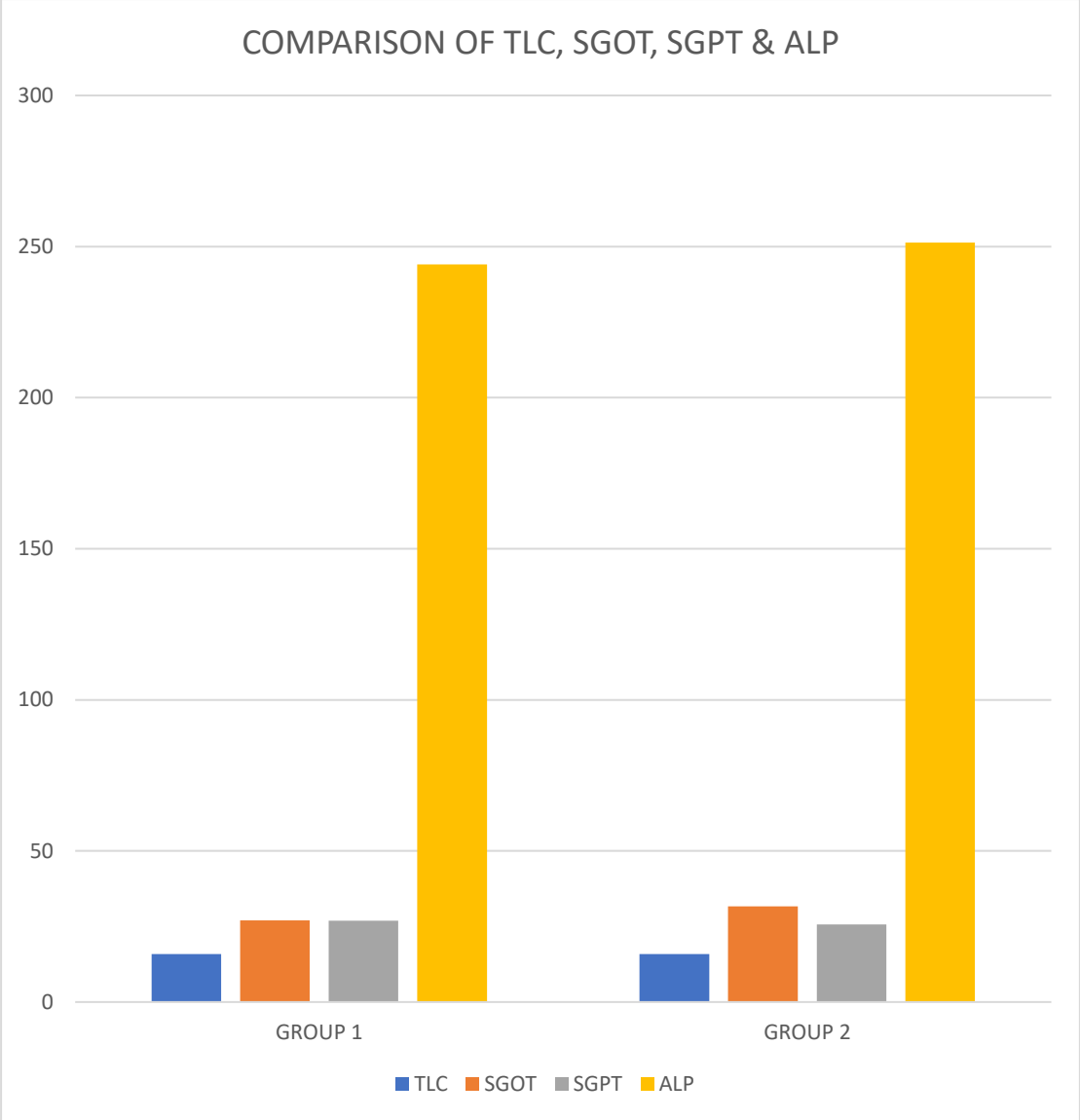


"Graph 7: Descriptive statistics of duration of pain (days)"

Table 8: Descriptive statistics of laboratory parameters

			95% Confidence Interval				
Parameters	**Group**	**Mean ± SD**	**Lower**	**Upper**	**Median**	**t value**	**p value**
TLC	Group 1	15.9 ± 0.4	15.08	16.7	16	0.0	1.0
	Group 2	15.9 ± 0.4	15.08	15.91	16		
SGOT	Group 1	27.0 ± 1.8	23.32	50.3	23	-9.56	1.74×10^{-13}
	Group 2	31.7 ± 2.0	27.51	36.03	29		
SGPT	Group 1	26.9 ± 14.9	21.8	32.1	20	0.4	0.6
	Group 2	25.7 ± 2.3	20.93	30.56	21.5		
ALP	Group 1	244.1 ± 7.8	228.20	260.0	248.5	-4.3	8.12×10^{-5}
	Group 2	251.3 ± 4.8	241.39	261.22	250		

Table 8 presents laboratory parameters for both groups. This analysis revealed that there was no statistically significant difference in TLC between the two groups ($t = 0.000$, $p = 1.000$), indicating that the leukocyte count remains comparable across both cohorts. Similarly, SGPT levels did not exhibit a significant difference ($t = 0.436$, $p = 0.666$), suggesting that variations in alanine aminotransferase are likely due to random fluctuations rather than a meaningful physiological disparity. Conversely, a highly significant difference was observed in SGOT levels between the groups ($t = -9.567$, $p < 0.0001$). The negative t-value suggests that Group 1 has significantly lower SGOT levels compared to Group 2, indicating a potential difference in hepatic function or cellular turnover between the two populations. Additionally, ALP levels were significantly different between the groups ($t = -4.306$, $p < 0.0001$), with Group 1 exhibiting lower ALP than other group 2.



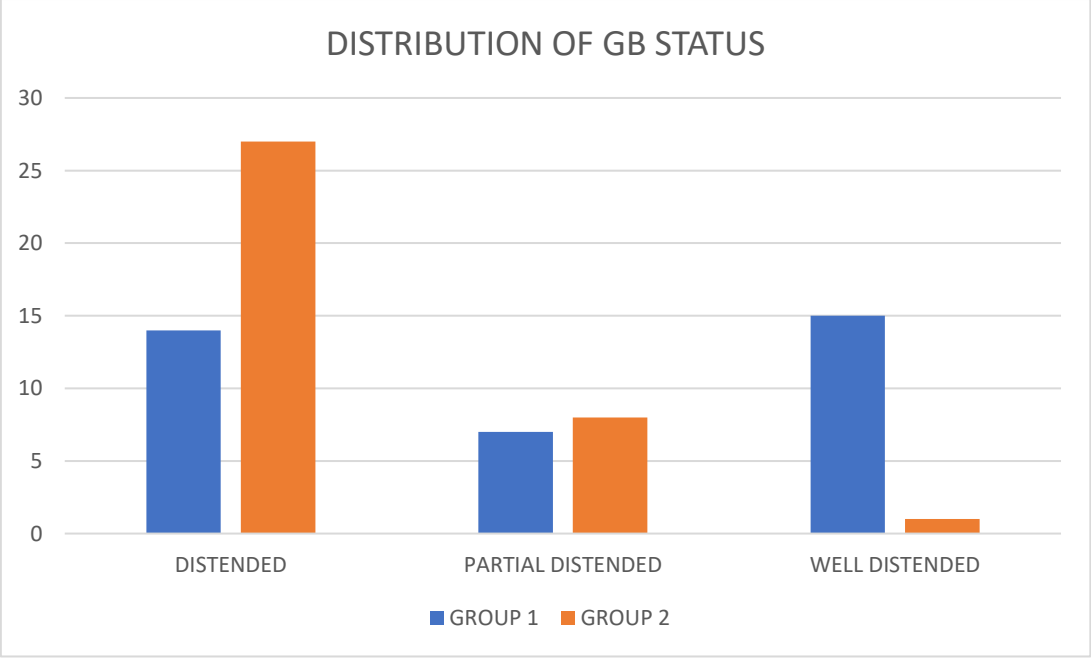
"Graph 8: Descriptive statistics of laboratory parameters"

Table 9: Distribution of study subjects according to Gall Bladder status according to USG findings

	Groups		
GB STATUS	**Group 1**	**Group 2**	**Total**
Partially distended	7	8	15
Distended	14	27	41
Well distended	15	1	16
Total	**36**	**36**	**72**

χ^2=16.44, p=<0.001

In this table, gallbladder status was evaluated in two groups, with a total of 72 patients. Group 1 consisted of 36 patients, while Group 2 also had 36 patients. The gallbladders were categorized into three statuses: partially distended, distended, well distended. In Group 1, 7 gallbladders were partially distended, 14 were distended, 15 were well distended. In contrast, Group 2 showed a higher number of distended gallbladders with 15 partially distended and 16 were well distended. p-value (0.00027) is much lower than the conventional significance level (0.05), this suggests a statistically significant association between GB status.



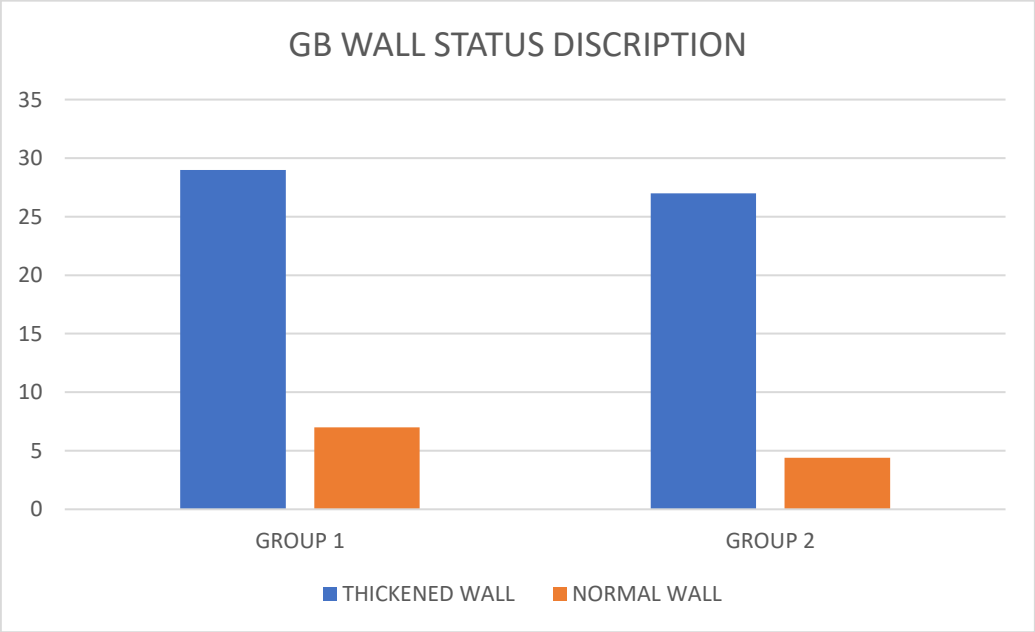
"Graph 9: Distribution of study subjects according to Gall Bladder status"

Table 10: Distribution of study subjects according to Gall Bladder wall thickness.

	Group		
GB wall thickened	**Group 1**	**Group 2**	**Total**
Normal wall	7	9	16
Thickened wall	29	27	56
Total	**36**	**36**	**72**

χ^2=0. 0804, p=<0.77

The table categorizes 72 gallbladder specimens into two groups based on the thickness of the gallbladder wall. In Group 1, consisting of 36 specimens, 29 displayed a thickened gallbladder wall, while 7 had a normal wall thickness. Conversely, in Group 2, also with 36 specimens, 27 showed a thickened wall, and 9 had a normal wall thickness. Overall, out of the total 72 specimens, 56 exhibited thickened walls, and 16 had normal wall thickness. Unlike the GB status, which showed a significant difference between groups, GB wall thickness does not appear to differ significantly between Group 1 and Group 2. This suggests that thickened GB walls are equally prevalent in both groups, and no group-specific factor seems to be influencing this condition.



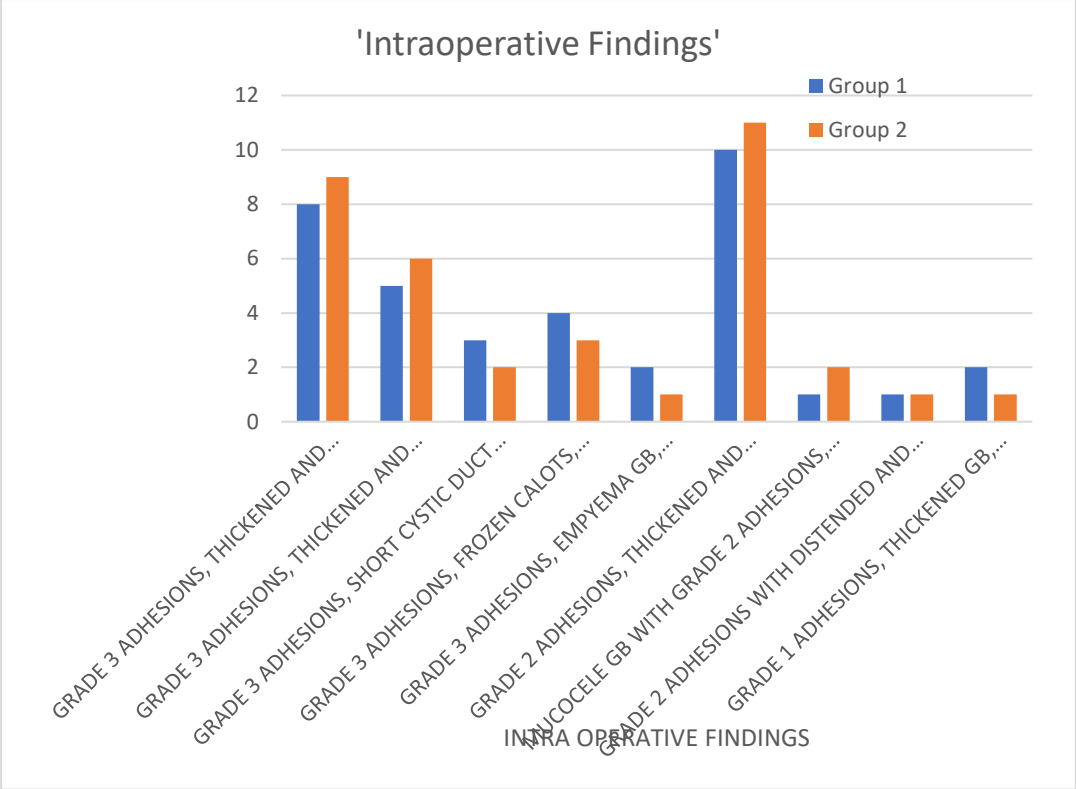
"Graph 10: Distribution of study subjects according to Gall Bladder wall thickness"

Table 11: Distribution of study subjects according to Intra Operative findings

Intraoperative Findings	Group 1	Group 2	Total
GRADE 3 ADHESIONS, THICKENED AND EDEMATOUS GB, NORMAL CALOTS ANATOMY	8	9	17
GRADE 3 ADHESIONS, THICKENED AND EDEMATOUS GB, FROZEN CALOTS ANATOMY	5	6	11
GRADE 3 ADHESIONS, SHORT CYSTIC DUCT THICKENED AND EDEMATOUS GB, NORMAL CALOTS ANATOMY	3	2	5
GRADE 3 ADHESIONS, FROZEN CALOTS, SHORT AND THICK CYSTIC DUCT	4	3	7
GRADE 3 ADHESIONS, EMPYEMA GB, THICKENED AND EDEMATOUS GB, NORMAL CALOTS ANATOMY	2	1	3
GRADE 2 ADHESIONS, THICKENED AND EDEMATOUS GB, NORMAL CALOTS ANATOMY	10	11	21
MUCOCELE GB WITH GRADE 2 ADHESIONS, THICKENED GB WALL WITH NORMAL CALOTS ANATOMY	1	2	3
GRADE 2 ADHESIONS WITH DISTENDED AND EDEMATOUS GB, PROMINENT CYSTIC ARTERY	1	1	2
GRADE 1 ADHESIONS, THICKENED GB, NORMAL CALOTS ANATOMY	2	1	3
TOTAL	36	36	72

(χ^2 = 1.54, p value= 0.992)

Table 11 summarizes the intraoperative findings for both groups. The Chi-square statistic was calculated as 1.54, with a corresponding p-value of 0.992. The most frequent observation was Grade 2 adhesions with a thickened and oedematous gallbladder and normal Calot's anatomy, seen in 21 patients (29.2%), Less common but notable were findings such as gallbladder empyema (3 cases), mucocele (3 cases), and prominent cystic artery (2 cases), which can further complicate intraoperative management. Since the p-value is much greater than 0.05, the results indicate that there is no statistically significant difference between Group 1 and Group 2 concerning intraoperative findings. The findings describe the severity of adhesions, gallbladder (GB) conditions, and anatomical variations in Calot's triangle.



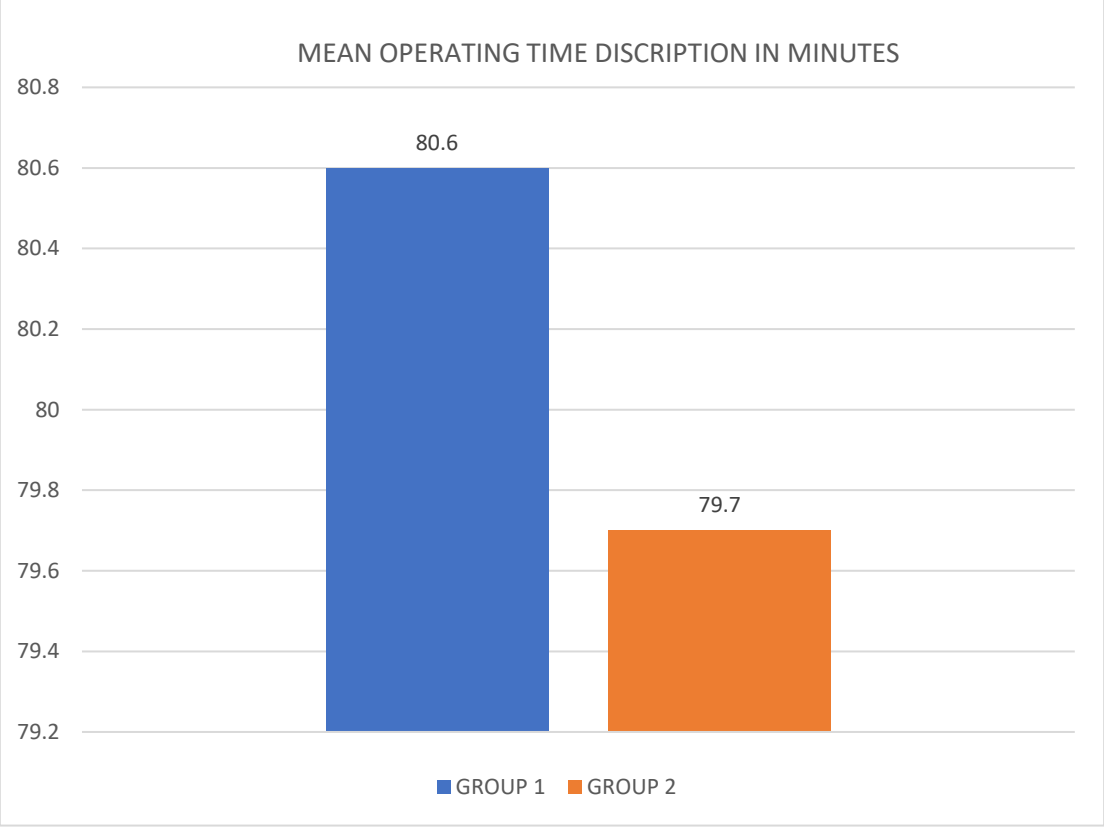
“Graph 11: Distribution of study subjects according to Intra Operative findings”

Table 12: Descriptive statistics of operative time

			95% Confidence Interval		
	Group	**Mean ± SD**	**Lower**	**Upper**	**Median**
Operating time (mins)	Group 1	80.6 ± 2.0	79.92	81.28	82.5
	Group 2	79.7 ± 3.2	78.62	80.78	80

T-test, p-value : 0.15

Table 12 summarized the descriptive statistics of operative time for the two groups. The mean operative time for Group 1 was 80.6 minutes with a standard deviation (SD) of 2.0 minutes. The 95% confidence interval for Group 1 ranged from 79.92 TO 81.28 minutes, with a median of 82.5 minutes. In contrast, Group 2 had a significantly shorter mean operative time of 79.7 minutes with an SD of 3.2 minutes. The independent t-test for the updated data yield t-statistic: 1.43 and p-value: 0.157. This p-value is greater than 0.05, indicating that the difference in mean operating times between Group 1 and Group 2 is not statistically significant at the 95% confidence level.



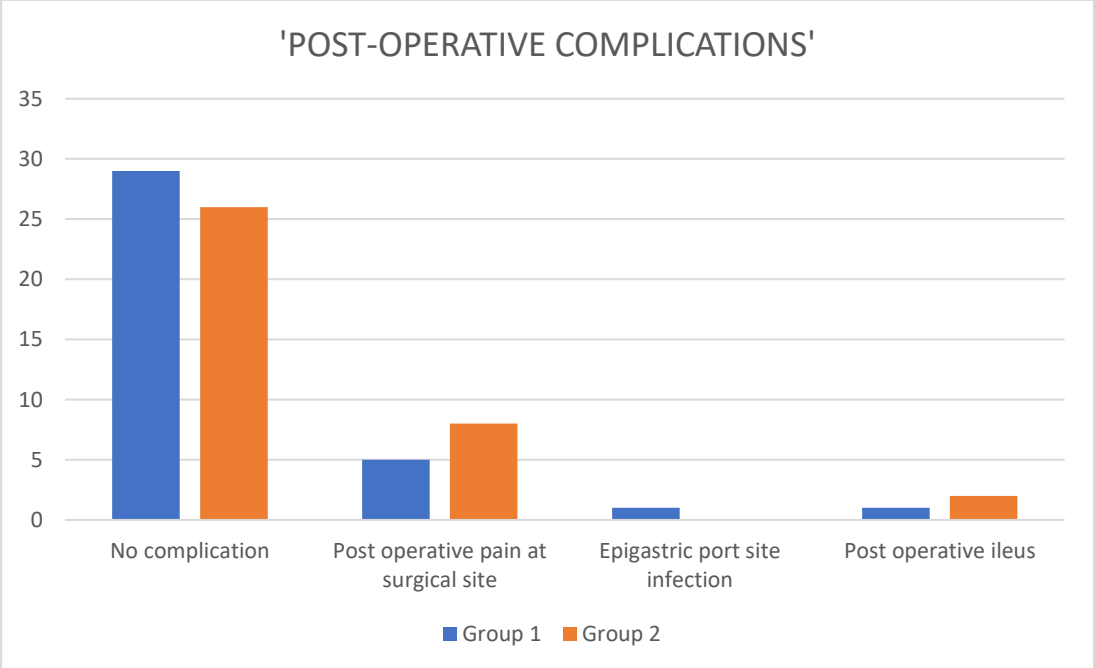
"Graph 12: Descriptive statistics of operative time"

Table 13: Distribution of study subjects according to post operative complications

POST-OPERATIVE COMPLICATIONS	Group 1	Group 2	Total
No complication	29	26	55
Post operative pain at surgical site	5	8	13
Epigastric port site infection	1	0	1
Post operative ileus	1	2	3
Total	**36**	**36**	**72**

χ^2=2.19 , p=0.53

Table 13 outlines the distribution of post-operative complications. Most participants in both groups experienced no complications. Post-operative pain was reported in a few subjects from both groups. The incidence of post-operative complications does not significantly differ between the two groups. The chi-square analysis indicated no statistically significant difference in post-operative complications between the groups.



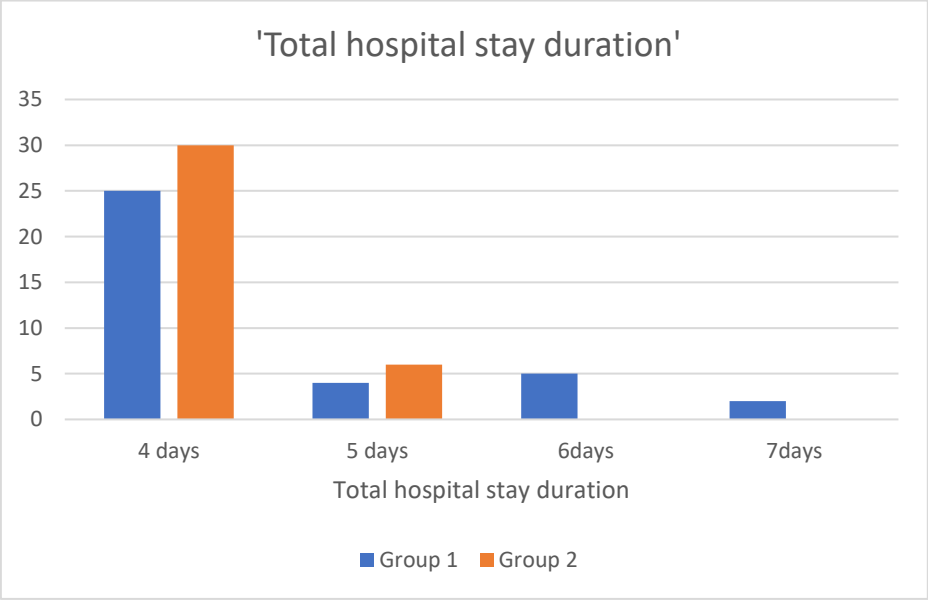
"Graph 13: Distribution of study subjects according to post operative complications"

Table 14: Distribution of study subjects according to total hospital stay duration

	Group		
Total hospital stay duration	**Group 1**	**Group 2**	**Total**
4 days	25	30	**55**
5 days	4	6	**10**
6days	5	0	**5**
7days	2	0	**2**
Total	**36**	**36**	**72**

χ^2=7.85, p=0.49

Table 14 summarized the distribution of study subjects based on the total duration of hospital stay for both groups. Most patients (76.4%) had a hospital stay of 4 days, with slightly more cases in Group 2 (30) compared to Group 1 (25). 5-day stays were reported in 10 cases, with a slightly higher count in Group 2 (6) than Group 1 (4). Longer hospital stays (6–7 days) were only observed in Group 1; 6 days: 5 cases (Group 1), 0 cases (Group 2) and 7 days: 2 cases (Group 1), 0 cases (Group 2). The chi-square test resulted in a value of 7.85 with a p-value of 0.49, indicating a no statistically significant difference in hospital stay duration between the two groups. This suggested that subjects in Group 1 were more likely to have longer hospital stays compared to those in Group 2.



"Graph 14: Distribution of study subjects according to total hospital stay duration"

DISCUSSION

DISCUSSION

Acute calculous cholecystitis (ACC) is an inflammation of the gallbladder that occurs when a gallstone blocks the cystic duct, resulting in bile accumulation and subsequent inflammation, being one the most common gall stone disease. Our study found that the age distribution between the early surgery group (Group 1) and the interval surgery group (Group 2) for acute cholecystitis cases was similar, with a mean age of 41.7 ± 11.8 years in Group 1 and 37.8 ± 10.7 years in Group 2. The age range extended from 18 to over 65 years, and the highest frequency of cases was seen in the 31–40 and 41–50 age groups, each with 21 patients (29.2% of the total study population). In the 18-20 age bracket, only 1 patient was observed in Group 2. In contrast, the age groups with the highest frequency were 31-40 in Group 1 (9 patients) and Group 2 (12 patients). The statistical analysis showed no significant difference between groups in terms of age distribution ($\chi^2 = 3.72$, $p = 0.59$), indicating that age was not a distinguishing factor in the choice of early versus interval laparoscopic cholecystectomy. Both groups had an equal number of patients (n=36), making a total of 72 participants in the study. **Malik et al.**[40] conducted a prospective comparative study of early laparoscopic cholecystectomy (ELC) and interval laparoscopic cholecystectomy (ILC) in patients with acute cholecystitis. In their study, both the early and interval cholecystectomy groups had 25 patients each, with age ranges of 19–65 years for the ELC group and 23–66 years for the ILC group. The p-value (0.089) indicated no statistically significant difference between the groups in terms of age distribution, like the present study's finding of a p-value of 0.59. The consistency in findings across these studies suggests that age alone does not influence the timing of laparoscopic cholecystectomy in cases of acute cholecystitis. In a study by **Yüksel et al.**,[41]which also assessed the timing of laparoscopic cholecystectomy for subacute calculous cholecystitis, early (ELC) and interval (ILC) procedures were performed on 31 and 43 patients, respectively. The median ages in this study were 57 years (range 35–73) for the ELC group and 55 years (range 28–75) for the ILC group, with a p-value of 0.052, indicating no significant age difference between the groups. Yüksel et al.'s[37] findings align closely with both the present study and Malik et al.,[36] reinforcing the notion that patient age does not significantly impact the decision for early versus interval laparoscopic cholecystectomy in cases of cholecystitis, as both approaches are feasible across similar age ranges.

The present study found that gender distribution was similar between the early surgery (Group 1) and interval surgery (Group 2) groups for acute cholecystitis, with females representing the majority in both groups. Group 1 had 25 females and 11 males, while Group 2 had 26 females and 10 males. In total, there were 51 females (70.8%) and 21 males (29.2%) across both groups. Statistical analysis indicated no significant difference in gender distribution between the two groups ($\chi^2 = 0.0672$, $p = 0.795$), suggesting that gender did not influence the decision for early versus interval laparoscopic cholecystectomy. **Yüksel et al.**[41] evaluated the timing of laparoscopic cholecystectomy for subacute calculous cholecystitis and reported similar gender distribution results between their early laparoscopic cholecystectomy (ELC) and interval laparoscopic cholecystectomy (ILC) groups, with a male-to-female ratio of 12:19 in the early laparoscopic cholecystectomy (ELC) group and 17:26 in the interval laparoscopic cholecystectomy (ILC) group. Although the gender ratio slightly favored females, statistical analysis showed no significant difference ($p = 0.067$), consistent with the present study's findings that gender did not significantly impact the timing of surgery. In a study by **Thomas et al**.,[47] socio-demographic factors, including gender, were analyzed for their influence on the timing of laparoscopic cholecystectomy. In this study, the ELC group had 16 males (47.1%) and 18 females (52.9%), while the ILC group had 9 males (27.3%) and 24 females (72.7%), with a p-value of 0.094. Although Thomas et al.[38] observed a higher percentage of females in the ILC group, the difference was not statistically significant, aligning with the findings of both Yüksel et al.[37] and the present study. These consistent findings across studies suggest that gender does not significantly influence the choice between early and interval cholecystectomy, emphasizing the appropriateness of both approaches for both male and female patients.

The present study found variability in the site of pain among patients undergoing early (Group 1) and interval (Group 2) laparoscopic cholecystectomy for acute cholecystitis. The most common pain location was the right hypochondrium (RHC), with 21 cases in Group 1 and 23 cases in Group 2, totaling 44 across both groups. Epigastric pain was also common, reported in 9 patients in Group 1 and 10 in Group 2, amounting to 19 cases, combined locations such as RHC with epigastrium (9 cases). Statistical analysis revealed no significant difference in pain distribution between the groups ($\chi^2 = 11.4$, $p = 0.56$), indicating that pain site was comparable between early and interval cholecystectomy cases. **Hegazy and Soliman**[39] analyzed pain characteristics between

early and interval cholecystectomy groups and found that, in the early group, 8 patients reported constant pain and 42 had colicky pain. In the interval group, 10 patients had constant pain and 40 experienced colicky pain. Around one third of the patients reported pain in the upper quadrant. These findings indicate that, while pain type (constant vs. colicky) varied slightly between groups, both early and interval procedures saw comparable pain patterns overall. This aligns with the present study's finding that pain location, rather than type, did not significantly differ based on surgery timing. **Latenstein et al.**[43] developed a clinical decision tool focused on symptomatic cholelithiasis patients, where pain was primarily located in the right upper quadrant or epigastric region. Their validation cohort (n=1067) reported right upper quadrant or epigastric pain in 91.4% of cases, a prevalence that underscores the findings in the present study, where RHC and epigastrium were the most frequent pain sites. Latenstein et al.[40] also documented that 67.2% of patients experienced biliary colic (all three Rome III criteria), like the pain presentation in Hegazy[39] and Soliman's study. These findings collectively suggest that pain location in the upper abdomen is a reliable indicator for cholecystectomy timing, regardless of whether it is managed as an early or interval procedure.

The present study found differences in symptoms prevalence between early (Group 1) and interval (Group 2) laparoscopic cholecystectomy groups for acute cholecystitis, with nausea/vomiting being the most common symptom. Group 1 had 16 cases of nausea/vomiting compared to 8 in Group 2 ($\chi^2 = 3.06$, $p = 0.08$), indicating a trend with statistical significance. Similarly, Fever was prevalent equally in both groups, with no significant differences between Group 1 and Group 2 for diabetes ($\chi^2 = 0.215$, $p > 0.05$). Overall, the symptom distribution was similar between early and interval cholecystectomy groups, suggesting that their presence did not significantly impact the choice of surgery timing. In the study by **Malik et al**.,[40] the distribution of abdominal pain was consistent across both early (ELC) and interval (ILC) cholecystectomy groups, with all patients reporting pain in both groups ($p = 0$). Nausea and vomiting were more frequent in the ELC group (22 cases) than in the ILC group (2 cases), yielding a p-value of 0.4, like the present study where nausea/vomiting was more prevalent in Group 1 but did not reach statistical significance. Malik et al.'s[36] findings further support the notion that nausea and vomiting may be more frequent in early cholecystectomy cases, although this difference is not consistently statistically

significant. **Thomas et al.**[47] examined comorbidities in their early and interval cholecystectomy cohorts, finding that 38.2% of patients in the ELC group and 45.5% in the ILC group had at least one comorbidity ($p = 0.549$). This aligns with the present study's finding of no significant difference in comorbidity presence between the two groups, indicating that comorbidity status alone does not drive the timing of cholecystectomy. These studies collectively demonstrate that while symptoms and comorbidities such as nausea, vomiting, jaundice, diabetes, and hypertension are common, they do not significantly impact the decision for early versus interval laparoscopic cholecystectomy.

The present study found that previous lower abdominal surgery was more common in the early surgery group (Group 1) compared to the interval surgery group (Group 2) for patients with acute cholecystitis. Group 1 had 7 patients with a history of prior lower abdominal surgery, while 10 patients in Group 2 reported this history. Statistical analysis yielded no significant difference in previous surgery history between the groups ($\chi^2 = 0.31$, $p = 0.57$), suggesting no possible trend where patients with a history of abdominal surgery may be more likely to undergo early cholecystectomy. **Kolla et al.**[31] conducted a study comparing early and delayed laparoscopic cholecystectomy in patients with acute cholecystitis. In their study, 4 patients in both the early and delayed groups had a history of previous lower abdominal surgery ($p = 0.433$), indicating no significant difference in the frequency of prior abdominal surgery between the groups. This is similar to the present study, where previous abdominal surgery did not significantly impact the timing of cholecystectomy, despite a higher count in the early surgery group.

The present study found a significant difference in the presence of pericholecystic edema between the early surgery (Group 1) and interval surgery (Group 2) groups. Pericholecystic edema was observed in 15 patients in Group 1 and in 29 of the patients in Group 2. The statistical analysis confirmed this difference as highly significant ($\chi^2 = 9.8$, $p < 0.001$), indicating that pericholecystic edema was more prevalent in patients who underwent interval laparoscopic cholecystectomy. This suggests that pericholecystic edema might be a characteristic radiological finding that prompts the choice of early or delayed intervention in cases of acute cholecystitis. In the study by **Thomas et al.,**[47] positive Murphy's sign, a clinical indicator commonly associated with acute cholecystitis, was reported in 50% of patients in the early laparoscopic

cholecystectomy (ELC) group and 39.4% in the interval laparoscopic cholecystectomy (ILC) group (p = 0.383). Although Murphy's sign was prevalent, there was no significant difference between the groups. This aligns with the current study's findings, where Murphy's sign was not assessed, but pericholecystic edema was specifically highlighted in the early surgery group. **Agrawal et al.**[44] similarly evaluated Murphy's sign as an indicator, finding it present in 56% of patients in both early and delayed groups (p = 0.999), which also showed no difference. This consistency in Murphy's sign contrasts with the present study's finding of a significant difference in pericholecystic edema, suggesting that pericholecystic edema may be a more specific imaging feature for deciding on early intervention in acute cholecystitis, whereas clinical signs like Murphy's sign alone do not significantly differentiate early from delayed treatment approaches.

The present study found a significant difference in the duration of pain between the early surgery (Group 1) and interval surgery (Group 2) groups for acute cholecystitis. Group 1 had the highest number of individuals experiencing pain for 1 day (14 people), while Group 2 had more individuals experiencing pain for 4 days (12 people). Both groups showed similar distributions across different pain durations, though Group 2 had slightly more individuals with longer pain durations (4 days) compared to Group 1. Statistical analysis suggests that there is no statistically significant difference in the distribution of pain duration between Group 1 and Group 2. **Kolla et al.**[31] compared the duration of acute symptoms in early versus delayed laparoscopic cholecystectomy groups, finding no significant difference between groups (p = 0.887). Their early group had a mean duration of symptoms of 35.1 ± 19.1 hours, and the delayed group had a mean of 36.1 ± 24.7 hours, suggesting that both groups experienced symptoms for a similar length of time before surgery. Additionally, only a small number of patients experienced symptoms for more than 3 days (2 in the early group and 5 in the delayed group, p = 0.329), which contrasts sharply with the findings in the present study, where the interval group had a considerably extended duration of pain lasting up to several months. This comparison highlights that while Kolla et al.'s[41] study found acute symptom duration to be comparable between groups, the present study observed a prolonged symptom duration in the interval group, possibly due to the delayed timing of surgery.

The present study found a significant difference in the total leukocyte count (TLC) between the early surgery (Group 1) and interval surgery (Group 2) groups. Group 1 had a mean TLC of 15.9 ± 0.4 cells/μL (95% CI: 15.8 to 16.7) with a median of 16, while Group 2 also had a mean TLC of 15.9 ± 0.4cells/μL (95% CI: 15.08 to 15.91) with a median of 16, showing a statistically significant difference ($t = 0.0$, $p = 1.0$). Other liver function tests, including SGOT and ALP, show significant differences between groups, with SGOT ($p =<0.05$), and ALP ($p <0.05$) all showing comparable values, suggesting that these parameters were influenced by the timing of surgery. **Agrawal et al.**[42] assessed similar biochemical parameters in early versus delayed laparoscopic cholecystectomy groups for acute cholecystitis. In their study, the TLC in the early and delayed groups was not significantly different, with median values of 10,800 and 11,200 cells/μL, respectively ($p = 0.341$). This contrasts with the present study, where TLC was significantly higher in the early surgery group, possibly reflecting an acute inflammatory response that was resolved over time in the interval group. **Agrawal et al.**[44] also reported non-significant differences for liver enzymes (SGOT and SGPT), consistent with the present study's findings for SGOT, SGPT, and ALP, indicating that these liver parameters may not be markedly affected by the timing of cholecystectomy. In the study by **Hegazy and Soliman**[42], the white blood cell (WBC) count and alkaline phosphatase (ALP) levels were measured in early and interval cholecystectomy groups. They found no significant differences in WBC (7.82 ± 1.41 × 10^9/L in the early group vs. 5.40 ± 1.069 × 10^9/L in the interval group, $p = 0.542$) or ALP levels (91.0 ± 30.7 IU/L vs. 90.96 ± 43.8 IU/L, $p = 0.518$), aligning with the present study's findings that ALP was comparable between groups. The consistent lack of significant differences in liver enzymes across studies supports the view that these enzymes may not be sensitive indicators for distinguishing early from interval laparoscopic cholecystectomy. However, the elevated TLC in the present study's early surgery group may suggest a more acute inflammatory response in early cholecystitis cases, reinforcing the importance of TLC as a possible indicator for the timing of intervention in acute cholecystitis cases.

The present study revealed significant differences in gallbladder (GB) characteristics between the early (Group 1) and interval (Group 2) surgery groups for acute cholecystitis. Regarding GB status, Group 1 showed a predominance of well-distended (15 cases) and distended (14 cases) gallbladders, while Group 2 had a higher frequency

of distended gallbladders (27 cases) (χ^2 = 16.4, p < 0.001). Additionally, GB wall thickening was significantly more common in Group 1 (29 cases) compared to Group 2 (27 cases) χ^2=0. 0804, p=<0.77 almost a similar trend; indicating that early cases were more likely to show signs of acute inflammation. **Hegazy and Soliman[42]** studied early and interval cholecystectomy groups and found that thickened, edematous gallbladders were present in 80% of early cases compared to 54% of interval cases, though this difference was not statistically significant (p = 0.436). This finding is consistent with the present study, which demonstrated a significantly higher prevalence of GB wall thickening in the early group. Both studies underscore that thickened GB walls are a characteristic of acute inflammation more common in early cholecystectomy cases, further supporting the association between wall thickening and the timing of intervention. **Raja et al.[45]** reported a significant increase in contracted gallbladders among interval cases (40%) compared to early cases (0%) (p < 0.001), which aligns with the current study, where contracted gallbladders were only observed in Group 2. Additionally, Raja et al.[43] found that interval cases often presented with dense adhesions, complicating surgical dissection. The present study's finding of fewer well-distended and more contracted gallbladders in the interval group reinforces this, suggesting that delayed intervention may lead to gallbladder contraction and fibrosis, potentially making surgery more challenging. Regarding gallstone characteristics, Hegazy[39] and Soliman found no significant difference in the presence of gallstones between early and delayed groups (100% in both), consistent with the present study's finding of multiple stones in both groups without a significant difference. This consistency suggests that the presence or number of stones may not be a deciding factor for surgical timing, emphasizing that other factors, such as GB wall thickness and distension, may be more critical in choosing early intervention for acute cholecystitis.

The present study found that among the 72 patients evaluated intraoperatively, findings were evenly distributed between Group 1 and Group 2, with 36 patients each. The most frequent observation was Grade 2 adhesions with a thickened and oedematous gallbladder and normal Calot's anatomy, seen in 21 patients (29.2%), indicating moderate inflammation but preserved anatomical clarity. Grade 3 adhesions with similar gallbladder changes and normal Calot's anatomy were noted in 17 cases (23.6%), reflecting more severe inflammation. Frozen Calot's triangle, often associated with higher surgical difficulty, was found in 11 cases with thickened GB and 7 cases

with short and thick cystic ducts, suggesting distorted anatomy and higher risk during dissection. Less common but notable were findings such as gallbladder empyema (3 cases), mucocele (3 cases), and prominent cystic artery (2 cases), which can further complicate intraoperative management. Overall, the data reflects a spectrum of inflammatory changes, with a significant number of patients presenting with advanced disease and complex anatomy, highlighting the importance of surgeon experience and potential need for intraoperative conversion or advanced techniques. These findings incline towards similar intraoperative difficulties in both the groups. **Malik et al.**[40] evaluated intraoperative complications in early (ELC) and interval (ILC) laparoscopic cholecystectomy groups, reporting complications such as aspiration in distended gallbladders (2 cases in ELC vs. 1 in ILC, $p = 0.02$) and gangrenous gallbladders (2 cases in ELC, none in ILC, $p = 0.04$). They also observed stone spillage and partial cholecystectomy in early cases only, indicating greater intraoperative complexity in the early group. These findings align with the present study, where complex conditions requiring open conversion or management of severe adhesions were observed exclusively in the early surgery group, further underscoring the increased inflammatory and anatomical challenges encountered during early cholecystectomy. **Yüksel et al.**[37] also reported a higher incidence of dissection difficulty at Calot's triangle in interval cases (20 cases) compared to early cases (10 cases), with a significant difference ($p = 0.008$). This contrasts with the present study, where Group 1 (early surgery) showed greater difficulty, as indicated by frequent findings of frozen Calot's anatomy and severe adhesions. However, both studies demonstrate that difficult anatomy at Calot's triangle can impact the timing of surgery and potentially complicate intraoperative management. Additionally, Yüksel et al.[37] reported recurrent cholecystitis and biliary complications more frequently in interval cases, which were not prominent findings in the present study, likely due to differences in patient selection or study design. Overall, these studies indicate that early cholecystectomy is associated with increased inflammatory and anatomical challenges, often requiring more complex surgical intervention. This differs with present study in terms of similar complexity in both the groups and underscores the importance of careful patient assessment when planning early laparoscopic cholecystectomy

The present study had a comparison of operative durations between the two groups shows Group 1 had a mean operating time of 80.6 ± 2.0 minutes, while Group 2

averaged 79.7 ± 3.2 minutes. Although both groups had overlapping 95% confidence intervals (Group 1: 79.92–81.28 mins; Group 2: 78.62–80.78 mins), suggesting no statistically significant difference, Group 1 demonstrated a slightly higher and more consistent operating time, as reflected by its narrower confidence interval and lower standard deviation. The median time was also longer in Group 1 (82.5 minutes) versus Group 2 (80 minutes), possibly reflecting more complex intraoperative findings such as frozen Calot's triangle or empyema in that group. These subtle differences may point to increased operative difficulty in Group 1, even though overall surgical times remain comparable. **Yüksel et al.**[41] reported median operating times of 95 minutes (range 45–140) for early laparoscopic cholecystectomy (ELC) and 100 minutes (range 40–136) for interval laparoscopic cholecystectomy (ILC), with no significant difference between the groups ($p = 0.054$). This finding contrasts with the present study, where the early group had a significantly longer operating time. The discrepancy may be due to different patient characteristics or study criteria; however, it underscores that operating time may not always differ consistently between early and interval groups, potentially varying based on specific intraoperative conditions. **Malik et al.**[40] reported that the duration of surgery in the early group averaged 2.27 ± 0.63 hours (approximately 136 minutes), while the interval group averaged 1.5 ± 1.41 hours (approximately 90 minutes), with a significant difference ($p = 0.045$). These results align with the present study, as early surgery also required longer operating times. The prolonged duration in early cases, as observed in both studies, suggests that acute inflammation, thicker adhesions, and anatomical challenges contribute to increased operative times, making early cholecystectomy technically more demanding. In summary, while Yüksel et al.[37] found no significant difference in operating time, the findings from Malik et al.[36] and the present study demonstrate that early cholecystectomy typically involves longer surgery durations, likely due to the acute inflammatory state. This suggests that surgeons should anticipate longer operating times in early interventions and be prepared for potential intraoperative complexities.

The present study found no significant difference in post-operative complications between the early surgery (Group 1) and interval surgery (Group 2) groups ($\chi^2 = 2.19$, $p = 0.53$). Most patients experienced no complications in either group (29 in Group 1 and 26 in Group 2), accounting for 55 of the 72 cases (76.3%). Among those with complications, post-operative pain at the surgical site was the most common, reported

by 5 patients in Group 1 and 8 in Group 2. Additional complications included a single case each of surgical site infection and post-operative ileus. These results suggest that post-operative complications were low and similar between early and interval cholecystectomy groups. **Malik et al.[40]** reported post-operative complications in early (ELC) and interval (ILC) laparoscopic cholecystectomy groups, noting that biliary leak occurred in 1 patient (4%) in the ELC group, while wound infections were observed in both groups (6 cases in ELC and 5 in ILC, $p = 0.02$). This differs slightly from the present study, where wound infection was rare, occurring only in 1 patient in Group 1. The lower incidence of wound infections and biliary leaks in the present study may reflect variations in surgical technique or patient management practices, although both studies indicate that post-operative complications remain generally low in both early and interval cholecystectomy groups. **Goel et al.[45]** also compared post-operative complications in early and delayed laparoscopic cholecystectomy groups. Wound infections were observed in 6% of early cases and 10% of interval cases, while biliary leaks occurred in 12% of early and 16% of interval cases, with a non-significant p-value (0.13). The present study's findings of minimal wound infections and a single bile duct injury are consistent with Goel et al.'s[44] observation that complications, including biliary issues, occur at low but comparable rates in both early and interval groups. Overall, these studies show that early laparoscopic cholecystectomy does not significantly increase the risk of post-operative complications compared to interval cholecystectomy. Although some variations in complication types exist, the findings support the safety and feasibility of early intervention for acute cholecystitis with minimal post-operative risks.

The present study found a statistically significant difference in the total hospital stay duration between the early surgery (Group 1) and interval surgery (Group 2) groups ($\chi^2 = 7.85$; $p = 0.049$). In Group 1, the majority of patients (25 out of 36) had a stay duration of 4 days, while a smaller number had stays of 5, 6, or 7 days. In Group 2, 30 out of 36 patients also had a hospital stay of 4 days, but the distribution included no stays of 6 or 7 days. These findings suggest that while a 4-day stay was common in both groups, early cholecystectomy (Group 1) showed slightly greater variability in hospital stay duration, with some cases extending beyond 5 days. **Thomas et al.[47]** compared the total hospital stay duration in early (ELC) and interval (ILC) laparoscopic cholecystectomy groups, reporting a significantly shorter mean hospital stay in the early group (mean

7.12 ± 3.01 days, median 7) compared to the interval group (mean 10.21 ± 4.46 days, median 9.5, p = 0.001). This contrasts with the present study, where both groups had a similar and relatively short hospital stay, most commonly around 4 days. The discrepancy may be due to different discharge policies or patient management practices, but both studies demonstrate that early cholecystectomy can lead to a reduced or comparable hospital stay compared to interval procedures. In a study by **Raja et al.**,[46] the mean post-operative stay was 3.89 ± 0.74 days for early cases and 4.09 ± 0.82 days for interval cases, with no significant difference between the groups (p = 0.214). This finding aligns with the present study's results, where both early and interval cholecystectomy groups showed similar hospital stay durations, supporting the feasibility of early discharge in early cholecystectomy cases without increasing overall hospitalization duration. These studies collectively suggest that early laparoscopic cholecystectomy for acute cholecystitis does not prolong hospital stay compared to interval surgery and, in some cases, may even reduce it. This finding supports early cholecystectomy as a practical option that does not increase the burden of hospital resources.

CONCLUSION

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- The age distribution between the two groups was not significantly different, as evidenced by a p-value of 0.59, suggesting comparable demographic composition in terms of age.
- Gender distribution was also similar between both groups with a p-value of 0.795, indicating no gender-based differences influencing the outcomes.
- Site of pain did not differ significantly between the groups with p value = 0.56, although there was a trend towards different pain locations, which did not reach statistical significance.
- Symptoms like nausea/vomiting with statical significance, fever was although evenly distributed across both groups, with no significant differences affecting the study outcomes.
- A marginal difference in previous lower abdominal surgeries suggested a trend (p=0.57) that was not statistically significant, indicating minor variations in surgical history.
- A significant finding was the presence of pericholecystic oedema predominantly in Group 1 ($p<0.001$), suggesting differences in clinical presentation or treatment responses at the time of presentation.
- The duration of pain was similar in both the groups (p=0.4), pointing to potentially no different underlying conditions or delays in treatment.
- Laboratory parameters showed a significant difference only in SGOT and ALP between both the groups, while other parameters like TLC and SGPT showing no significant differences.
- Gallbladder status varied significantly, with differences in distension and oedema between the groups ($p<0.05$), possibly reflecting differences in the timing or type of surgical intervention.
- Gallbladder wall thickening was predominantly seen in Group 1 ($p<0.7$), indicating a potential indicator of more severe or different disease progression in this group.
- Intraoperative findings ranged from mild adhesions to complex cases with frozen Calot's triangle and empyema, indicating varying surgical difficulty. Group 1, with more complex findings, showed a slightly longer operating time

(mean: 80.6 mins) compared to Group 2 (mean: 79.7 mins), reflecting the impact of anatomical challenges on operative duration.

- Post-operative complications were similar across groups (p=0.5), indicating that immediate surgical outcomes were comparable despite differences in operative findings.
- Hospital stay durations were significantly different (p=0.49), with Group 1 experiencing longer stays, likely related to the more complex surgeries and intraoperative challenges encountered.

SUMMARY

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The study comprehensively evaluated two groups of patients undergoing laparoscopic cholecystectomy, analysing a range of demographic and clinical parameters to discern any significant differences and their implications on surgical outcomes.

The two groups showed no significant differences in baseline characteristics, including age ($p = 0.59$), gender distribution ($p = 0.795$), site of pain ($p = 0.56$), or duration of symptoms ($p = 0.4$). While nausea and vomiting were significantly more common in one group, other clinical features such as fever were similarly distributed. A significant difference was noted in the presence of pericholecystic oedema, predominantly in Group 1 ($p < 0.001$), and gallbladder status also varied significantly in terms of distension and oedema ($p < 0.05$). Laboratory values revealed significant differences only in SGOT and ALP levels. Intraoperative findings indicated more complex pathology in Group 1, including frozen Calot's triangle and empyema, which corresponded with a slightly longer mean operative time (80.6 vs. 79.7 minutes) but was not statically significant. Despite these differences, postoperative complications were comparable between groups ($p = 0.5$). The length of hospital stay was also not significantly different ($p = 0.49$), suggesting that the intraoperative challenges did not substantially prolong recovery time.

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ANNEXURES

SANTOSH MEDICAL COLLEGE AND HOSPITAL (GHAZIABAD)

INFORMED CONSENT

I, _____, Son/Daughter/Wife of _____, residing at _____, hereby voluntarily give my informed consent to take part in the research study titled:

"Evaluation of Early vs Interval Laparoscopic Cholecystectomy for Acute Cholecystitis: An Observational Study."

I have been thoroughly informed by Dr. _____ in a language I understand about the purpose and nature of this study, including the procedures and laboratory tests that will be conducted. I have also been made aware of the duration of the study and the guidelines I need to follow while participating.

I freely agree to participate in the above study and understand that I can withdraw from it at any point, without affecting my right to receive continued medical care at Santosh Hospital, Ghaziabad, U.P.

Participant's Signature: _____

Participant's Name: _____

Date: _____

Investigator's Signature: _____

Investigator's Name (Dr.): _____

Date: _____

संतोष मेडिकल कॉलेज एवं अस्पताल (गाजियाबाद)

<u>सहमति पत्र (सूचित)</u>

मैं _____ बेटा/ बेटी/ पत्नी_____निवासी_____ ____ घोषणा करता हूं कि डॉ ._____, ने मुझे मेरी भाषा में अपने अध्ययन "**Evaluation of early vs interval laparoscopic cholecystectomy for acute cholecystitis; an observationalstudy"** के उद्देश्य के बारे में, और अध्ययन के दौरान अपनाई जाने वाली विभिन्न प्रयोगशाला जांच के बारे में सूचित कर दिया है। मुझे अध्ययनकी अवधि और उसके दौरान अपनाए जाने वाले निर्देश भी मेरी भाषा मे समझा दिए गए हैं| मैं उपरोक्त अध्ययन में बिना किसी दबाव के दाखिला ले रहा हूं और पूर्ण सहमति दे रहा हूं | सन्तोष अस्पताल, गाजियाबाद में अपने आगे के उपचार पर बिना प्रतिकूल प्रभाव डाले इस अध्ययन से और प्रयोगशाला जांच की प्रकृति से मैं जब चाहूँ बाहर जाने के अपने अधिकार को सुरक्षित रख रहा हूं |

रोगी / रोगी के रिश्तेदार के हस्ताक्षर

नाम

दिनांक:

डॉक्टर के हस्ताक्षर

नाम: डॉ शालू

पदनाम: पीजी

मेरी उपस्थिति में मरीज ने पूरी तरह से डाकटर के बताए गए अध्ययन और निर्देशों को समझने के बादअपनी स्वतंत्र इच्छा से ऊपर के फार्म पर हस्ताक्षर किए हैं ।

हस्ताक्षर

MASTER CHART

1. IP NO
2. NAME
3. AGE
4. GENDER
5. HISTORY SUGGESTIVE OF ACUTE CHOLECYSTITIS
6. COMORBIDITIES
7. BMI
8. GB STATUS
9. GB WALL THICKNESS
10. GB STONE
11. TLC
12. SGOT
13. SGPT
14. ALP
15. INTRA OP FINDINGS
16. OPERATING TIME
17. POST-OPERATIVE COMPLICATIONS
18. TOTAL HOSPITAL STAY DURATION
19. TOTAL COST OF PROCEDURE